PROTEINS AND NUCLEIC ACIDS FROM MENINGITIS/SEPSIS-ASSOCIATED *ESCHERICHIA COLI*

All documents cited herein are incorporated by reference in their entirety.

RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/654,632, filed February 18, 2005 and U.S. Provisional Application No. 60/712,720, filed August 29, 2005. The teachings of both these applications are incorporated herein in their entirety by reference.

TECHNICAL FIELD

This invention is in the field of *Escherichia coli* biology, and in particular relates to immunogens for use in immunising against extraintestinal pathogenic *E.coli* (ExPEC) strains.

BACKGROUND ART

Few microorganisms are as versatile as *E.coli*. As well as being an important member of the normal intestinal microflora of mammals, it has been widely exploited as a host in recombinant DNA technology. In addition, however, *E.coli* can also be a deadly pathogen.

E.coli strains have traditionally been classified as either commensal or pathogenic, and pathogenic strains are then sub-classified as intestinal or extraintestinal strains. Classification may also be based on the 'K' antigens. The best-studied 'K' antigen is 'K1', which is considered to be the major determinant of virulence among those strains of *E.coli* that cause neonatal meningitis. The K1 antigen is a homopolymer of α-2,8-linked sialic acid, like the capsular saccharide of serogroup B meningococcus.

More recent taxonomic techniques such as multilocus enzyme electrophoresis (MLEE) classify *E.coli* into five phylogenetic groups (A, B1, B2, D & E), and these groupings do not match the traditional ones. For instance, MLEE group B1 includes both commensal and pathogenic strains, and group D includes both intestinal and extraintestinal strains.

The extraintestinal pathogenic strains (or 'ExPEC' strains [1]) of *E.coli* fall into MLEE groups B2 and D, and include both uropathogenic (UPEC) strains and meningitis/sepsis-associated (MNEC) strains. UPEC strains cause urinary tract infections (UTIs), and are a common cause of cystitis. They also cause pyelonephritis (and its complications such as sepsis) and catheter-associated infections. MNEC strains cause neonatal meningitis (0.1 cases per 1000 live births) with case fatality rates ranging from 25 to 40%, and are also responsible for around 1/6 of sepsis cases.

Most previous ExPEC vaccines have been based on cell lysates or on cellular structures. SOLCOUROVAC™ includes ten different heat-killed bacteria including six ExPEC strains, and a successful phase II clinical trial was reported in reference 2. URO-VAXOM™ is an oral tablet vaccine containing lyophilised bacterial lysates of 18 selected *E.coli* strains [3]. Baxter Vaccines developed a UTI vaccine based on pili from 6 to 10 different strains, but this product has been abandoned. MedImmune developed a product called MEDI 516 based on the FimH adhesin complex

[4], but phase II clinical trials shows inadequate efficacy. Moreover, there was a risk with this vaccine that it would also affect non-pathogenic $FimH^{+ve}$ strains in the normal intestinal flora, and it was expected that it would be effective against UPEC strains only, because of its bladder-specific adherence mechanism, leaving other ExPEC strains uncontrolled.

There is thus a need for improved ExPEC vaccines, including a need to move away from crude cell lysates and towards better-defined molecules, and a need to identify further antigens that are suitable for inclusion in vaccines, particularly antigens that are prevalent among clinical ExpEC strains without also being found in commensal strains. Within the ExPEC group, there is a particular need to identify antigens suitable for immunising against MNEC strains.

One way of addressing these needs was reported in reference 5, where the inventors looked for genes present in genomes of MLEE types B2 and D but absent from MLEE types A and B1. Further comparative approaches, based on subtractive hybridisation, have been reported in references 6 & 7. Virulence genes in ExPEC strains have also been identified in reference 8. Reference 9 discloses an analysis of four pathogenicity islands in UPEC *E.coli* strain 536.

Reference 10 used the genome sequence of UPEC (O6:K2:H1) strain CFT073 [11,12] to identify sequences not present in non-pathogenic *E.coli* strains. Reference 13 discloses a comparison of the genome sequence of *E.coli* human pyelonephritis isolate 536 (O6:K15:H31), an UPEC, with sequence data for strains CFT073 (UPEC), EDL933 (enterohemorrhagic) and MG1655 (non-pathogenic laboratory strain). Genome sequences of pathogenic strains are available in the databases under accession numbers AE005174, BA000007 and NC-004431. A sequence from a non-pathogenic strain is available under accession number U00096.

It is an object of the invention to provide further antigens for use in immunisation against pathogenic *E.coli* strains, particularly against ExPEC strains, and more particularly against MNEC strains.

SUMMARY OF THE INVENTION

The inventors have identified various open reading frames from a strain of *E.coli* responsible for neonatal meningitis (MNEC), and have identified a subset of these that is of particular interest for preparing compositions for immunising against MNEC infections.

In one aspect, the present invention relates to a polypeptide comprising: (a) an amino acid sequence selected from the group consisting of SEQ ID NOs 706, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240, 242, 244, 246, 248, 250, 252, 254, 256, 258, 260, 262, 264, 266, 268, 270, 272, 274, 276, 278, 280, 282, 284,

286, 288, 290, 292, 294, 296, 298, 300, 302, 304, 306, 308, 310, 312, 314, 316, 318, 320, 322, 324, 326, 328, 330, 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354, 356, 358, 360, 362, 364, 366, 368, 370, 372, 374, 376, 378, 380, 382, 384, 386, 388, 390, 392, 394, 396, 398, 400, 402, 404, 406, 408, 410, 412, 414, 416, 418, 420, 422, 424, 426, 428, 430, 432, 434, 436, 438, 440, 442, 444, 446, 448, 450, 452, 454, 456, 458, 460, 462, 464, 466, 468, 470, 472, 474, 476, 478, 480, 482, 484, 486, 488, 490, 492, 494, 496, 498, 500, 502, 504, 506, 508, 510, 512, 514, 516, 518, 520, 522, 524, 526, 528, 530, 532, 534, 536, 538, 540, 542, 544, 546, 548, 550, 552, 554, 556, 558, 560, 562, 564, 566, 568, 570, 572, 574, 576, 578, 580, 582, 584, 586, 588, 590, 592, 594, 596, 598, 600, 602, 604, 606, 608, 610, 612, 614, 616, 618, 620, 622, 624, 626, 628, 630, 632, 634, 636, 638, 640, 642, 644, 646, 648, 650, 652, 654, 656, 658, 660, 662, 664, 666, 668, 670, 672, 674, 676, 678, 680, 682, 684, 686, 688, 690, 692, 694, 696, 698, 700, 702, 704, 708, 710, 712, 714, 716, 718, 720, 722, 724, 726, 728, 730, 732, 734, 736, 738, 740, 742, 744, 746, 748, 750, 752, 754, 756, 758, 760, 762, 764, 766, 768, 770, 772, 774, 776, 778, 780, 782, 784, 786, 788, 790, 792, 794, 796, 798, 800, 802, 804, 806, 808, 810, 812, 814, 816, 818, 820, 822, 824, 826, 828, 830, 832, 834, 836, 838, 840, 842, 844, 846, 848, 850, 852, 854, 856, 858, 860, 862, 864, 866, 868, 870, 872, 874, 876, 878, 880, 882, 884, 886, 888, 890, 892, 894, 896, 898, 900, 902, 904, 906, 908, 910, 912, 914, 916, 918, 920, 922, 924, 926, 928, 930, 932, 934, 936, 938, 940, 942, 944, 946, 948, 950, 952, 954, 956, 958, 960, 962, 964, 966, 968, 970, 972, 974, 976, 978, 980, 982, 984, 986, 988, 990, 992, 994, 996, 998, 1000, 1002, 1004, 1006, 1008, 1010, 1012, 1014, 1016, 1018, 1020, 1022, 1024, 1026, 1028, 1030, 1032, 1034, 1036, 1038, 1040, 1042, 1044, 1046, 1048, 1050, 1052, 1054, 1056, 1058, 1060, 1062, 1064, 1066, 1068, 1070, 1072, 1074, 1076, 1078, 1080, 1082, 1084, 1086, 1088, 1090, 1092, 1094, 1096, 1098, 1100, 1102, 1104, 1106, 1108, 1110, 1112, 1114, 1116, 1118, 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150, 1152, 1154, 1156, 1158, 1160, 1162, 1164, 1166, 1168, 1170, 1172, 1174, 1176, 1178, 1180, 1182, 1184, 1186, 1188, 1190, 1192, 1194, 1196, 1198, 1200, 1202, 1204, 1206, 1208, 1210, 1212, 1214, 1216, 1218, 1220, 1222, 1224, 1226, 1228, 1230, 1232, 1234, 1236, 1238, 1240, 1242, 1244, 1246, 1248, 1250, 1252, 1254, 1256, 1258, 1260, 1262, 1264, 1266, 1268, 1270, 1272, 1274, 1276, 1278, 1280, 1282, 1284, 1286, 1288, 1290, 1292, 1294, 1296, 1298, 1300, 1302, 1304, 1306, 1308, 1310, 1312, 1314, 1316, 1318, 1320, 1322, 1324, 1326, 1328, 1330, 1332, 1334, 1336, 1338, 1340, 1342, 1344, 1346, 1348, 1350, 1352, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372, 1374, 1376, 1378, 1380, 1382, 1384, 1386, 1388, 1390, 1392, 1394, 1396, 1398, 1400, 1402, 1404, 1406, 1408, 1410, 1412, 1414, 1416, 1418, 1420, 1422, 1424, 1426, 1428, 1430, 1432, 1434, 1436, 1438, 1440, 1442, 1444, 1446, 1448, 1450, 1452, 1454, 1456, 1458, 1460, 1462, 1464, 1466, 1468, 1470, 1472, 1474, 1476, 1478, 1480, 1482, 1484, 1486, 1488, 1490, 1492, 1494, 1496, 1498, 1500, 1502, 1504, 1506, 1508, 1510, 1512, 1514, 1516, 1518, 1520, 1522, 1524, 1526, 1528, 1530, 1532, 1534, 1536, 1538, 1540, 1542, 1544, 1546, 1548, 1550, 1552, 1554, 1556, 1558, 1560, 1562, 1564, 1566, 1568, 1570, 1572, 1574, 1576, 1578, 1580, 1582, 1584, 1586, 1588, 1590, 1592, 1594, 1596, 1598, 1600, 1602, 1604, 1606, 1608, 1610, 1612, 1614, 1616, 1618, 1620, 1622, 1624, 1626, 1628, 1630, 1632, 1634, 1636, 1638, 1640, 1642, 1644,

1646, 1648, 1650, 1652, 1654, 1656, 1658, 1660, 1662, 1664, 1666, 1668, 1670, 1672, 1674, 1676, 1678, 1680, 1682, 1684, 1686, 1688, 1690, 1692, 1694, 1696, 1698, 1700, 1702, 1704, 1706, 1708, 1710, 1712, 1714, 1716, 1718, 1720, 1722, 1724, 1726, 1728, 1730, 1732, 1734, 1736, 1738, 1740, 1742, 1744, 1746, 1748, 1750, 1752, 1754, 1756, 1758, 1760, 1762, 1764, 1766, 1768, 1770, 1772, 1774, 1776, 1778, 1780, 1782, 1784, 1786, 1788, 1790, 1792, 1794, 1796, 1798, 1800, 1802, 1804, 1806, 1808, 1810, 1812, 1814, 1816, 1818, 1820, 1822, 1824, 1826, 1828, 1830, 1832, 1834, 1836, 1838, 1840, 1842, 1844, 1846, 1848, 1850, 1852, 1854, 1856, 1858, 1860, 1862, 1864, 1866, 1868, 1870, 1872, 1874, 1876, 1878, 1880, 1882, 1884, 1886, 1888, 1890, 1892, 1894, 1896, 1898, 1900, 1902, 1904, 1906, 1908, 1910, 1912, 1914, 1916, 1918, 1920, 1922, 1924, 1926, 1928, 1930, 1932, 1934, 1936, 1938, 1940, 1942, 1944, 1946, 1948, 1950, 1952, 1954, 1956, 1958, 1960, 1962, 1964, 1966, 1968, 1970, 1972, 1974, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034, 2036, 2038, 2040, 2042, 2044, 2046, 2048, 2050, 2052, 2054, 2056, 2058, 2060, 2062, 2064, 2066, 2068, 2070, 2072, 2074, 2076, 2078, 2080, 2082, 2084, 2086, 2088, 2090, 2092, 2094, 2096, 2098, 2100, 2102, 2104, 2106, 2108, 2110, 2112, 2114, 2116, 2118, 2120, 2122, 2124, 2126, 2128, 2130, 2132, 2134, 2136, 2138, 2140, 2142, 2144, 2146, 2148, 2150, 2152, 2154, 2156, 2158, 2160, 2162, 2164, 2166, 2168, 2170, 2172, 2174, 2176, 2178, 2180, 2182, 2184, 2186, 2188, 2190, 2192, 2194, 2196, 2198, 2200, 2202, 2204, 2206, 2208, 2210, 2212, 2214, 2216, 2218, 2220, 2222, 2224, 2226, 2228, 2230, 2232, 2234, 2236, 2238, 2240, 2242, 2244, 2246, 2248, 2250, 2252, 2254, 2256, 2258, 2260, 2262, 2264, 2266, 2268, 2270, 2272, 2274, 2276, 2278, 2280, 2282, 2284, 2286, 2288, 2290, 2292, 2294, 2296, 2298, 2300, 2302, 2304, 2306, 2308, 2310, 2312, 2314, 2316, 2318, 2320, 2322, 2324, 2326, 2328, 2330, 2332, 2334, 2336, 2338, 2340, 2342, 2344, 2346, 2348, 2350, 2352, 2354, 2356, 2358, 2360, 2362, 2364, 2366, 2368, 2370, 2372, 2374, 2376, 2378, 2380, 2382, 2384, 2386, 2388, 2390, 2392, 2394, 2396, 2398, 2400, 2402, 2404, 2406, 2408, 2410, 2412, 2414, 2416, 2418, 2420, 2422, 2424, 2426, 2428, 2430, 2432, 2434, 2436, 2438, 2440, 2442, 2444, 2446, 2448, 2450, 2452, 2454, 2456, 2458, 2460, 2462, 2464, 2466, 2468, 2470, 2472, 2474, 2476, 2478, 2480, 2482, 2484, 2486, 2488, 2490, 2492, 2494, 2496, 2498, 2500, 2502, 2504, 2506, 2508, 2510, 2512, 2514, 2516, 2518, 2520, 2522, 2524, 2526, 2528, 2530, 2532, 2534, 2536, 2538, 2540, 2542, 2544, 2546, 2548, 2550, 2552, 2554, 2556, 2558, 2560, 2562, 2564, 2566, 2568, 2570, 2572, 2574, 2576, 2578, 2580, 2582, 2584, 2586, 2588, 2590, 2592, 2594, 2596, 2598, 2600, 2602, 2604, 2606, 2608, 2610, 2612, 2614, 2616, 2618, 2620, 2622, 2624, 2626, 2628, 2630, 2632, 2634, 2636, 2638, 2640, 2642, 2644, 2646, 2648, 2650, 2652, 2654, 2656, 2658, 2660, 2662, 2664, 2666, 2668, 2670, 2672, 2674, 2676, 2678, 2680, 2682, 2684, 2686, 2688, 2690, 2692, 2694, 2696, 2698, 2700, 2702, 2704, 2706, 2708, 2710, 2712, 2714, 2716, 2718, 2720, 2722, 2724, 2726, 2728, 2730, 2732, 2734, 2736, 2738, 2740, 2742, 2744, 2746, 2748, 2750, 2752, 2754, 2756, 2758, 2760, 2762, 2764, 2766, 2768, 2770, 2772, 2774, 2776, 2778, 2780, 2782, 2784, 2786, 2788, 2790, 2792, 2794, 2796, 2798, 2800, 2802, 2804, 2806, 2808, 2810, 2812, 2814, 2816, 2818, 2820, 2822, 2824, 2826, 2828, 2830, 2832, 2834, 2836, 2838, 2840, 2842, 2844, 2846, 2848, 2850, 2852, 2854, 2856, 2858, 2860,

2862, 2864, 2866, 2868, 2870, 2872, 2874, 2876, 2878, 2880, 2882, 2884, 2886, 2888, 2890, 2892, 2894, 2896, 2898, 2900, 2902, 2904, 2906, 2908, 2910, 2912, 2914, 2916, 2918, 2920, 2922, 2924, 2926, 2928, 2930, 2932, 2934, 2936, 2938, 2940, 2942, 2944, 2946, 2948, 2950, 2952, 2954, 2956, 2958, 2960, 2962, 2964, 2966, 2968, 2970, 2972, 2974, 2976, 2978, 2980, 2982, 2984, 2986, 2988, 2990, 2992, 2994, 2996, 2998, 3000, 3002, 3004, 3006, 3008, 3010, 3012, 3014, 3016, 3018, 3020, 3022, 3024, 3026, 3028, 3030, 3032, 3034, 3036, 3038, 3040, 3042, 3044, 3046, 3048, 3050, 3052, 3054, 3056, 3058, 3060, 3062, 3064, 3066, 3068, 3070, 3072, 3074, 3076, 3078, 3080, 3082, 3084, 3086, 3088, 3090, 3092, 3094, 3096, 3098, 3100, 3102, 3104, 3106, 3108, 3110, 3112, 3114, 3116, 3118, 3120, 3122, 3124, 3126, 3128, 3130, 3132, 3134, 3136, 3138, 3140, 3142, 3144, 3146, 3148, 3150, 3152, 3154, 3156, 3158, 3160, 3162, 3164, 3166, 3168, 3170, 3172, 3174, 3176, 3178, 3180, 3182, 3184, 3186, 3188, 3190, 3192, 3194, 3196, 3198, 3200, 3202, 3204, 3206, 3208, 3210, 3212, 3214, 3216, 3218, 3220, 3222, 3224, 3226, 3228, 3230, 3232, 3234, 3236, 3238, 3240, 3242, 3244, 3246, 3248, 3250, 3252, 3254, 3256, 3258, 3260, 3262, 3264, 3266, 3268, 3270, 3272, 3274, 3276, 3278, 3280, 3282, 3284, 3286, 3288, 3290, 3292, 3294, 3296, 3298, 3300, 3302, 3304, 3306, 3308, 3310, 3312, 3314, 3316, 3318, 3320, 3322, 3324, 3326, 3328, 3330, 3332, 3334, 3336, 3338, 3340, 3342, 3344, 3346, 3348, 3350, 3352, 3354, 3356, 3358, 3360, 3362, 3364, 3366, 3368, 3370, 3372, 3374, 3376, 3378, 3380, 3382, 3384, 3386, 3388, 3390, 3392, 3394, 3396, 3398, 3400, 3402, 3404, 3406, 3408, 3410, 3412, 3414, 3416, 3418, 3420, 3422, 3424, 3426, 3428, 3430, 3432, 3434, 3436, 3438, 3440, 3442, 3444, 3446, 3448, 3450, 3452, 3454, 3456, 3458, 3460, 3462, 3464, 3466, 3468, 3470, 3472, 3474, 3476, 3478, 3480, 3482, 3484, 3486, 3488, 3490, 3492, 3494, 3496, 3498, 3500, 3502, 3504, 3506, 3508, 3510, 3512, 3514, 3516, 3518, 3520, 3522, 3524, 3526, 3528, 3530, 3532, 3534, 3536, 3538, 3540, 3542, 3544, 3546, 3548, 3550, 3552, 3554, 3556, 3558, 3560, 3562, 3564, 3566, 3568, 3570, 3572, 3574, 3576, 3578, 3580, 3582, 3584, 3586, 3588, 3590, 3592, 3594, 3596, 3598, 3600, 3602, 3604, 3606, 3608, 3610, 3612, 3614, 3616, 3618, 3620, 3622, 3624, 3626, 3628, 3630, 3632, 3634, 3636, 3638, 3640, 3642, 3644, 3646, 3648, 3650, 3652, 3654, 3656, 3658, 3660, 3662, 3664, 3666, 3668, 3670, 3672, 3674, 3676, 3678, 3680, 3682, 3684, 3686, 3688, 3690, 3692, 3694, 3696, 3698, 3700, 3702, 3704, 3706, 3708, 3710, 3712, 3714, 3716, 3718, 3720, 3722, 3724, 3726, 3728, 3730, 3732, 3734, 3736, 3738, 3740, 3742, 3744, 3746, 3748, 3750, 3752, 3754, 3756, 3758, 3760, 3762, 3764, 3766, 3768, 3770, 3772, 3774, 3776, 3778, 3780, 3782, 3784, 3786, 3788, 3790, 3792, 3794, 3796, 3798, 3800, 3802, 3804, 3806, 3808, 3810, 3812, 3814, 3816, 3818, 3820, 3822, 3824, 3826, 3828, 3830, 3832, 3834, 3836, 3838, 3840, 3842, 3844, 3846, 3848, 3850, 3852, 3854, 3856, 3858, 3860, 3862, 3864, 3866, 3868, 3870, 3872, 3874, 3876, 3878, 3880, 3882, 3884, 3886, 3888, 3890, 3892, 3894, 3896, 3898, 3900, 3902, 3904, 3906, 3908, 3910, 3912, 3914, 3916, 3918, 3920, 3922, 3924, 3926, 3928, 3930, 3932, 3934, 3936, 3938, 3940, 3942, 3944, 3946, 3948, 3950, 3952, 3954, 3956, 3958, 3960, 3962, 3964, 3966, 3968, 3970, 3972, 3974, 3976, 3978, 3980, 3982, 3984, 3986, 3988, 3990, 3992, 3994, 3996, 3998, 4000, 4002, 4004, 4006, 4008, 4010, 4012, 4014, 4016, 4018, 4020, 4022, 4024, 4026, 4028, 4030, 4032, 4034, 4036, 4038, 4040, 4042, 4044, 4046, 4048, 4050, 4052, 4054, 4056, 4058, 4060, 4062, 4064, 4066, 4068, 4070, 4072, 4074, 4076,

4078, 4080, 4082, 4084, 4086, 4088, 4090, 4092, 4094, 4096, 4098, 4100, 4102, 4104, 4106, 4108, 4110, 4112, 4114, 4116, 4118, 4120, 4122, 4124, 4126, 4128, 4130, 4132, 4134, 4136, 4138, 4140, 4142, 4144, 4146, 4148, 4150, 4152, 4154, 4156, 4158, 4160, 4162, 4164, 4166, 4168, 4170, 4172, 4174, 4176, 4178, 4180, 4182, 4184, 4186, 4188, 4190, 4192, 4194, 4196, 4198, 4200, 4202, 4204, 4206, 4208, 4210, 4212, 4214, 4216, 4218, 4220, 4222, 4224, 4226, 4228, 4230, 4232, 4234, 4236, 4238, 4240, 4242, 4244, 4246, 4248, 4250, 4252, 4254, 4256, 4258, 4260, 4262, 4264, 4266, 4268, 4270, 4272, 4274, 4276, 4278, 4280, 4282, 4284, 4286, 4288, 4290, 4292, 4294, 4296, 4298, 4300, 4302, 4304, 4306, 4308, 4310, 4312, 4314, 4316, 4318, 4320, 4322, 4324, 4326, 4328, 4330, 4332, 4334, 4336, 4338, 4340, 4342, 4344, 4346, 4348, 4350, 4352, 4354, 4356, 4358, 4360, 4362, 4364, 4366, 4368, 4370, 4372, 4374, 4376, 4378, 4380, 4382, 4384, 4386, 4388, 4390, 4392, 4394, 4396, 4398, 4400, 4402, 4404, 4406, 4408, 4410, 4412, 4414, 4416, 4418, 4420, 4422, 4424, 4426, 4428, 4430, 4432, 4434, 4436, 4438, 4440, 4442, 4444, 4446, 4448, 4450, 4452, 4454, 4456, 4458, 4460, 4462, 4464, 4466, 4468, 4470, 4472, 4474, 4476, 4478, 4480, 4482, 4484, 4486, 4488, 4490, 4492, 4494, 4496, 4498, 4500, 4502, 4504, 4506, 4508, 4510, 4512, 4514, 4516, 4518, 4520, 4522, 4524, 4526, 4528, 4530, 4532, 4534, 4536, 4538, 4540, 4542, 4544, 4546, 4548, 4550, 4552, 4554, 4556, 4558, 4560, 4562, 4564, 4566, 4568, 4570, 4572, 4574, 4576, 4578, 4580, 4582, 4584, 4586, 4588, 4590, 4592, 4594, 4596, 4598, 4600, 4602, 4604, 4606, 4608, 4610, 4612, 4614, 4616, 4618, 4620, 4622, 4624, 4626, 4628, 4630, 4632, 4634, 4636, 4638, 4640, 4642, 4644, 4646, 4648, 4650, 4652, 4654, 4656, 4658, 4660, 4662, 4664, 4666, 4668, 4670, 4672, 4674, 4676, 4678, 4680, 4682, 4684, 4686, 4688, 4690, 4692, 4694, 4696, 4698, 4700, 4702, 4704, 4706, 4708, 4710, 4712, 4714, 4716, 4718, 4720, 4722, 4724, 4726, 4728, 4730, 4732, 4734, 4736, 4738, 4740, 4742, 4744, 4746, 4748, 4750, 4752, 4754, 4756, 4758, 4760, 4762, 4764, 4766, 4768, 4770, 4772, 4774, 4776, 4778, 4780, 4782, 4784, 4786, 4788, 4790, 4792, 4794, 4796, 4798, 4800, 4802, 4804, 4806, 4808, 4810, 4812, 4814, 4816, 4818, 4820, 4822, 4824, 4826, 4828, 4830, 4832, 4834, 4836, 4838, 4840, 4842, 4844, 4846, 4848, 4850, 4852, 4854, 4856, 4858, 4860, 4862, 4864, 4866, 4868, 4870, 4872, 4874, 4876, 4878, 4880, 4882, 4884, 4886, 4888, 4890, 4892, 4894, 4896, 4898, 4900, 4902, 4904, 4906, 4908, 4910, 4912, 4914, 4916, 4918, 4920, 4922, 4924, 4926, 4928, 4930, 4932, 4934, 4936, 4938, 4940, 4942, 4944, 4946, 4948, 4950, 4952, 4954, 4956, 4958, 4960, 4962, 4964, 4966, 4968, 4970, 4972, 4974, 4976, 4978, 4980, 4982, 4984, 4986, 4988, 4990, 4992, 4994, 4996, 4998, 5000, 5002, 5004, 5006, 5008, 5010, 5012, 5014, 5016, 5018, 5020, 5022, 5024, 5026, 5028, 5030, 5032, 5034, 5036, 5038, 5040, 5042, 5044, 5046, 5048, 5050, 5052, 5054, 5056, 5058, 5060, 5062, 5064, 5066, 5068, 5070, 5072, 5074, 5076, 5078, 5080, 5082, 5084, 5086, 5088, 5090, 5092, 5094, 5096, 5098, 5100, 5102, 5104, 5106, 5108, 5110, 5112, 5114, 5116, 5118, 5120, 5122, 5124, 5126, 5128, 5130, 5132, 5134, 5136, 5138, 5140, 5142, 5144, 5146, 5148, 5150, 5152, 5154, 5156, 5158, 5160, 5162, 5164, 5166, 5168, 5170, 5172, 5174, 5176, 5178, 5180, 5182, 5184, 5186, 5188, 5190, 5192, 5194, 5196, 5198, 5200, 5202, 5204, 5206, 5208, 5210, 5212, 5214, 5216, 5218, 5220, 5222, 5224, 5226, 5228, 5230, 5232, 5234, 5236, 5238, 5240, 5242, 5244, 5246, 5248, 5250, 5252, 5254, 5256, 5258, 5260, 5262, 5264, 5266, 5268, 5270, 5272, 5274, 5276, 5278, 5280, 5282, 5284, 5286, 5288, 5290, 5292,

CT/US06/05913

5294, 5296, 5298, 5300, 5302, 5304, 5306, 5308, 5310, 5312, 5314, 5316, 5318, 5320, 5322, 5324, 5326, 5328, 5330, 5332, 5334, 5336, 5338, 5340, 5342, 5344, 5346, 5348, 5350, 5352, 5354, 5356, 5358, 5360, 5362, 5364, 5366, 5368, 5370, 5372, 5374, 5376, 5378, 5380, 5382, 5384, 5386, 5388, 5390, 5392, 5394, 5396, 5398, 5400, 5402, 5404, 5406, 5408, 5410, 5412, 5414, 5416, 5418, 5420, 5422, 5424, 5426, 5428, 5430, 5432, 5434, 5436, 5438, 5440, 5442, 5444, 5446, 5448, 5450, 5452, 5454, 5456, 5458, 5460, 5462, 5464, 5466, 5468, 5470, 5472, 5474, 5476, 5478, 5480, 5482, 5484, 5486, 5488, 5490, 5492, 5494, 5496, 5498, 5500, 5502, 5504, 5506, 5508, 5510, 5512, 5514, 5516, 5518, 5520, 5522, 5524, 5526, 5528, 5530, 5532, 5534, 5536, 5538, 5540, 5542, 5544, 5546, 5548, 5550, 5552, 5554, 5556, 5558, 5560, 5562, 5564, 5566, 5568, 5570, 5572, 5574, 5576, 5578, 5580, 5582, 5584, 5586, 5588, 5590, 5592, 5594, 5596, 5598, 5600, 5602, 5604, 5606, 5608, 5610, 5612, 5614, 5616, 5618, 5620, 5622, 5624, 5626, 5628, 5630, 5632, 5634, 5636, 5638, 5640, 5642, 5644, 5646, 5648, 5650, 5652, 5654, 5656, 5658, 5660, 5662, 5664, 5666, 5668, 5670, 5672, 5674, 5676, 5678, 5680, 5682, 5684, 5686, 5688, 5690, 5692, 5694, 5696, 5698, 5700, 5702, 5704, 5706, 5708, 5710, 5712, 5714, 5716, 5718, 5720, 5722, 5724, 5726, 5728, 5730, 5732, 5734, 5736, 5738, 5740, 5742, 5744, 5746, 5748, 5750, 5752, 5754, 5756, 5758, 5760, 5762, 5764, 5766, 5768, 5770, 5772, 5774, 5776, 5778, 5780, 5782, 5784, 5786, 5788, 5790, 5792, 5794, 5796, 5798, 5800, 5802, 5804, 5806, 5808, 5810, 5812, 5814, 5816, 5818, 5820, 5822, 5824, 5826, 5828, 5830, 5832, 5834, 5836, 5838, 5840, 5842, 5844, 5846, 5848, 5850, 5852, 5854, 5856, 5858, 5860, 5862, 5864, 5866, 5868, 5870, 5872, 5874, 5876, 5878, 5880, 5882, 5884, 5886, 5888, 5890, 5892, 5894, 5896, 5898, 5900, 5902, 5904, 5906, 5908, 5910, 5912, 5914, 5916, 5918, 5920, 5922, 5924, 5926, 5928, 5930, 5932, 5934, 5936, 5938, 5940, 5942, 5944, 5946, 5948, 5950, 5952, 5954, 5956, 5958, 5960, 5962, 5964, 5966, 5968, 5970, 5972, 5974, 5976, 5978, 5980, 5982, 5984, 5986, 5988, 5990, 5992, 5994, 5996, 5998, 6000, 6002, 6004, 6006, 6008, 6010, 6012, 6014, 6016, 6018, 6020, 6022, 6024, 6026, 6028, 6030, 6032, 6034, 6036, 6038, 6040, 6042, 6044, 6046, 6048, 6050, 6052, 6054, 6056, 6058, 6060, 6062, 6064, 6066, 6068, 6070, 6072, 6074, 6076, 6078, 6080, 6082, 6084, 6086, 6088, 6090, 6092, 6094, 6096, 6098, 6100, 6102, 6104, 6106, 6108, 6110, 6112, 6114, 6116, 6118, 6120, 6122, 6124, 6126, 6128, 6130, 6132, 6134, 6136, 6138, 6140, 6142, 6144, 6146, 6148, 6150, 6152, 6154, 6156, 6158, 6160, 6162, 6164, 6166, 6168, 6170, 6172, 6174, 6176, 6178, 6180, 6182, 6184, 6186, 6188, 6190, 6192, 6194, 6196, 6198, 6200, 6202, 6204, 6206, 6208, 6210, 6212, 6214, 6216, 6218, 6220, 6222, 6224, 6226, 6228, 6230, 6232, 6234, 6236, 6238, 6240, 6242, 6244, 6246, 6248, 6250, 6252, 6254, 6256, 6258, 6260, 6262, 6264, 6266, 6268, 6270, 6272, 6274, 6276, 6278, 6280, 6282, 6284, 6286, 6288, 6290, 6292, 6294, 6296, 6298, 6300, 6302, 6304, 6306, 6308, 6310, 6312, 6314, 6316, 6318, 6320, 6322, 6324, 6326, 6328, 6330, 6332, 6334, 6336, 6338, 6340, 6342, 6344, 6346, 6348, 6350, 6352, 6354, 6356, 6358, 6360, 6362, 6364, 6366, 6368, 6370, 6372, 6374, 6376, 6378, 6380, 6382, 6384, 6386, 6388, 6390, 6392, 6394, 6396, 6398, 6400, 6402, 6404, 6406, 6408, 6410, 6412, 6414, 6416, 6418, 6420, 6422, 6424, 6426, 6428, 6430, 6432, 6434, 6436, 6438, 6440, 6442, 6444, 6446, 6448, 6450, 6452, 6454, 6456, 6458, 6460, 6462, 6464, 6466, 6468, 6470, 6472, 6474, 6476, 6478, 6480, 6482, 6484, 6486, 6488, 6490, 6492, 6494, 6496, 6498, 6500, 6502, 6504, 6506, 6508,

PCT/US2006/005913
6510, 6512, 6514, 6516, 6518, 6520, 6522, 6524, 6526, 6528, 6530, 6532, 6534, 6536, 6538, 6540, 6542, 6544, 6546, 6548, 6550, 6552, 6554, 6556, 6558, 6560, 6562, 6564, 6566, 6568, 6570, 6572, 6574, 6576, 6578, 6580, 6582, 6584, 6586, 6588, 6590, 6592, 6594, 6596, 6598, 6600, 6602, 6604, 6606, 6608, 6610, 6612, 6614, 6616, 6618, 6620, 6622, 6624, 6626, 6628, 6630, 6632, 6634, 6636, 6638, 6640, 6642, 6644, 6646, 6648, 6650, 6652, 6654, 6656, 6658, 6660, 6662, 6664, 6666, 6668, 6670, 6672, 6674, 6676, 6678, 6680, 6682, 6684, 6686, 6688, 6690, 6692, 6694, 6696, 6698, 6700, 6702, 6704, 6706, 6708, 6710, 6712, 6714, 6716, 6718, 6720, 6722, 6724, 6726, 6728, 6730, 6732, 6734, 6736, 6738, 6740, 6742, 6744, 6746, 6748, 6750, 6752, 6754, 6756, 6758, 6760, 6762, 6764, 6766, 6768, 6770, 6772, 6774, 6776, 6778, 6780, 6782, 6784, 6786, 6788, 6790, 6792, 6794, 6796, 6798, 6800, 6802, 6804, 6806, 6808, 6810, 6812, 6814, 6816, 6818, 6820, 6822, 6824, 6826, 6828, 6830, 6832, 6834, 6836, 6838, 6840, 6842, 6844, 6846, 6848, 6850, 6852, 6854, 6856, 6858, 6860, 6862, 6864, 6866, 6868, 6870, 6872, 6874, 6876, 6878, 6880, 6882, 6884, 6886, 6888, 6890, 6892, 6894, 6896, 6898, 6900, 6902, 6904, 6906, 6908, 6910, 6912, 6914, 6916, 6918, 6920, 6922, 6924, 6926, 6928, 6930, 6932, 6934, 6936, 6938, 6940, 6942, 6944, 6946, 6948, 6950, 6952, 6954, 6956, 6958, 6960, 6962, 6964, 6966, 6968, 6970, 6972, 6974, 6976, 6978, 6980, 6982, 6984, 6986, 6988, 6990, 6992, 6994, 6996, 6998, 7000, 7002, 7004, 7006, 7008, 7010, 7012, 7014, 7016, 7018, 7020, 7022, 7024, 7026, 7028, 7030, 7032, 7034, 7036, 7038, 7040, 7042, 7044, 7046, 7048, 7050, 7052, 7054, 7056, 7058, 7060, 7062, 7064, 7066, 7068, 7070, 7072, 7074, 7076, 7078, 7080, 7082, 7084, 7086, 7088, 7090, 7092, 7094, 7096, 7098, 7100, 7102, 7104, 7106, 7108, 7110, 7112, 7114, 7116, 7118, 7120, 7122, 7124, 7126, 7128, 7130, 7132, 7134, 7136, 7138, 7140, 7142, 7144, 7146, 7148, 7150, 7152, 7154, 7156, 7158, 7160, 7162, 7164, 7166, 7168, 7170, 7172, 7174, 7176, 7178, 7180, 7182, 7184, 7186, 7188, 7190, 7192, 7194, 7196, 7198, 7200, 7202, 7204, 7206, 7208, 7210, 7212, 7214, 7216, 7218, 7220, 7222, 7224, 7226, 7228, 7230, 7232, 7234, 7236, 7238, 7240, 7242, 7244, 7246, 7248, 7250, 7252, 7254, 7256, 7258, 7260, 7262, 7264, 7266, 7268, 7270, 7272, 7274, 7276, 7278, 7280, 7282, 7284, 7286, 7288, 7290, 7292, 7294, 7296, 7298, 7300, 7302, 7304, 7306, 7308, 7310, 7312, 7314, 7316, 7318, 7320, 7322, 7324, 7326, 7328, 7330, 7332, 7334, 7336, 7338, 7340, 7342, 7344, 7346, 7348, 7350, 7352, 7354, 7356, 7358, 7360, 7362, 7364, 7366, 7368, 7370, 7372, 7374, 7376, 7378, 7380, 7382, 7384, 7386, 7388, 7390, 7392, 7394, 7396, 7398, 7400, 7402, 7404, 7406, 7408, 7410, 7412, 7414, 7416, 7418, 7420, 7422, 7424, 7426, 7428, 7430, 7432, 7434, 7436, 7438, 7440, 7442, 7444, 7446, 7448, 7450, 7452, 7454, 7456, 7458, 7460, 7462, 7464, 7466, 7468, 7470, 7472, 7474, 7476, 7478, 7480, 7482, 7484, 7486, 7488, 7490, 7492, 7494, 7496, 7498, 7500, 7502, 7504, 7506, 7508, 7510, 7512, 7514, 7516, 7518, 7520, 7522, 7524, 7526, 7528, 7530, 7532, 7534, 7536, 7538, 7540, 7542, 7544, 7546, 7548, 7550, 7552, 7554, 7556, 7558, 7560, 7562, 7564, 7566, 7568, 7570, 7572, 7574, 7576, 7578, 7580, 7582, 7584, 7586, 7588, 7590, 7592, 7594, 7596, 7598, 7600, 7602, 7604, 7606, 7608, 7610, 7612, 7614, 7616, 7618, 7620, 7622, 7624, 7626, 7628, 7630, 7632, 7634, 7636, 7638, 7640, 7642, 7644, 7646, 7648, 7650, 7652, 7654, 7656, 7658, 7660, 7662, 7664, 7666, 7668, 7670, 7672, 7674, 7676, 7678, 7680, 7682, 7684, 7686, 7688, 7690, 7692, 7694, 7696, 7698, 7700, 7702, 7704, 7706, 7708, 7710, 7712, 7714, 7716, 7718, 7720, 7722, 7724,

7726, 7728, 7730, 7732, 7734, 7736, 7738, 7740, 7742, 7744, 7746, 7748, 7750, 7752, 7754, 7756, 7758, 7760, 7762, 7764, 7766, 7768, 7770, 7772, 7774, 7776, 7778, 7780, 7782, 7784, 7786, 7788, 7790, 7792, 7794, 7796, 7798, 7800, 7802, 7804, 7806, 7808, 7810, 7812, 7814, 7816, 7818, 7820, 7822, 7824, 7826, 7828, 7830, 7832, 7834, 7836, 7838, 7840, 7842, 7844, 7846, 7848, 7850, 7852, 7854, 7856, 7858, 7860, 7862, 7864, 7866, 7868, 7870, 7872, 7874, 7876, 7878, 7880, 7882, 7884, 7886, 7888, 7890, 7892, 7894, 7896, 7898, 7900, 7902, 7904, 7906, 7908, 7910, 7912, 7914, 7916, 7918, 7920, 7922, 7924, 7926, 7928, 7930, 7932, 7934, 7936, 7938, 7940, 7942, 7944, 7946, 7948, 7950, 7952, 7954, 7956, 7958, 7960, 7962, 7964, 7966, 7968, 7970, 7972, 7974, 7976, 7978, 7980, 7982, 7984, 7986, 7988, 7990, 7992, 7994, 7996, 7998, 8000, 8002, 8004, 8006, 8008, 8010, 8012, 8014, 8016, 8018, 8020, 8022, 8024, 8026, 8028, 8030, 8032, 8034, 8036, 8038, 8040, 8042, 8044, 8046, 8048, 8050, 8052, 8054, 8056, 8058, 8060, 8062, 8064, 8066, 8068, 8070, 8072, 8074, 8076, 8078, 8080, 8082, 8084, 8086, 8088, 8090, 8092, 8094, 8096, 8098, 8100, 8102, 8104, 8106, 8108, 8110, 8112, 8114, 8116, 8118, 8120, 8122, 8124, 8126, 8128, 8130, 8132, 8134, 8136, 8138, 8140, 8142, 8144, 8146, 8148, 8150, 8152, 8154, 8156, 8158, 8160, 8162, 8164, 8166, 8168, 8170, 8172, 8174, 8176, 8178, 8180, 8182, 8184, 8186, 8188, 8190, 8192, 8194, 8196, 8198, 8200, 8202, 8204, 8206, 8208, 8210, 8212, 8214, 8216, 8218, 8220, 8222, 8224, 8226, 8228, 8230, 8232, 8234, 8236, 8238, 8240, 8242, 8244, 8246, 8248, 8250, 8252, 8254, 8256, 8258, 8260, 8262, 8264, 8266, 8268, 8270, 8272, 8274, 8276, 8278, 8280, 8282, 8284, 8286, 8288, 8290, 8292, 8294, 8296, 8298, 8300, 8302, 8304, 8306, 8308, 8310, 8312, 8314, 8316, 8318, 8320, 8322, 8324, 8326, 8328, 8330, 8332, 8334, 8336, 8338, 8340, 8342, 8344, 8346, 8348, 8350, 8352, 8354, 8356, 8358, 8360, 8362, 8364, 8366, 8368, 8370, 8372, 8374, 8376, 8378, 8380, 8382, 8384, 8386, 8388, 8390, 8392, 8394, 8396, 8398, 8400, 8402, 8404, 8406, 8408, 8410, 8412, 8414, 8416, 8418, 8420, 8422, 8424, 8426, 8428, 8430, 8432, 8434, 8436, 8438, 8440, 8442, 8444, 8446, 8448, 8450, 8452, 8454, 8456, 8458, 8460, 8462, 8464, 8466, 8468, 8470, 8472, 8474, 8476, 8478, 8480, 8482, 8484, 8486, 8488, 8490, 8492, 8494, 8496, 8498, 8500, 8502, 8504, 8506, 8508, 8510, 8512, 8514, 8516, 8518, 8520, 8522, 8524, 8526, 8528, 8530, 8532, 8534, 8536, 8538, 8540, 8542, 8544, 8546, 8548, 8550, 8552, 8554, 8556, 8558, 8560, 8562, 8564, 8566, 8568, 8570, 8572, 8574, 8576, 8578, 8580, 8582, 8584, 8586, 8588, 8590, 8592, 8594, 8596, 8598, 8600, 8602, 8604, 8606, 8608, 8610, 8612, 8614, 8616, 8618, 8620, 8622, 8624, 8626, 8628, 8630, 8632, 8634, 8636, 8638, 8640, 8642, 8644, 8646, 8648, 8650, 8652, 8654, 8656, 8658, 8660, 8662, 8664, 8666, 8668, 8670, 8672, 8674, 8676, 8678, 8680, 8682, 8684, 8686, 8688, 8690, 8692, 8694, 8696, 8698, 8700, 8702, 8704, 8706, 8708, 8710, 8712, 8714, 8716, 8718, 8720, 8722, 8724, 8726, 8728, 8730, 8732, 8734, 8736, 8738, 8740, 8742, 8744, 8746, 8748, 8750, 8752, 8754, 8756, 8758, 8760, 8762, 8764, 8766, 8768, 8770, 8772, 8774, 8776, 8778, 8780, 8782, 8784, 8786, 8788, 8790, 8792, 8794, 8796, 8798, 8800, 8802, 8804, 8806, 8808, 8810, 8812, 8814, 8816, 8818, 8820, 8822, 8824, 8826, 8828, 8830, 8832, 8834, 8836, 8838, 8840, 8842, 8844, 8846, 8848, 8850, 8852, 8854, 8856, 8858, 8860, 8862, 8864, 8866, 8868, 8870, 8872, 8874, 8876, 8878, 8880, 8882, 8884, 8886, 8888, 8890, 8892, 8894, 8896, 8898, 8900, 8902, 8904, 8906, 8908, 8910, 8912, 8914, 8916, 8918, 8920, 8922, 8924, 8926, 8928, 8930, 8932, 8934, 8936, 8938, 8940,

ETHIDIUM BROMIDE
8942, 8944, 8946, 8948, 8950, 8952, 8954, 8956, 8958, 8960, 8962, 8964, 8966, 8968, 8970, 8972, 8974, 8976, 8978, 8980, 8982, 8984, 8986, 8988, 8990, 8992, 8994, 8996, 8998, 9000, 9002, 9004, 9006, 9008, 9010, 9012, 9014, 9016, 9018, 9020, 9022, 9024, 9026, 9028, 9030, 9032, 9034, 9036, 9038, 9040, 9042, 9044, 9046, 9048, 9050, 9052, 9054, 9056, 9058, 9060, 9062, 9064, 9066, 9068, 9070, 9072, 9074, 9076, 9078, 9080, 9082, 9084, 9086, 9088, 9090, 9092, 9094, 9096, 9098, 9100, 9102, 9104, 9106, 9108, 9110, 9112, 9114, 9116, 9118, 9120, 9122, 9124, 9126, 9128, 9130, 9132, 9134, 9136, 9138, 9140, 9142, 9144, 9146, 9148, 9150, 9152, 9154, 9156, 9158, 9160, 9162, 9164, 9166, 9168, 9170, 9172, 9174, 9176, 9178, 9180, 9182, 9184, 9186, 9188, 9190, 9192, 9194, 9196, 9198, 9200, 9202, 9204, 9206, 9208, 9210, 9212, 9214, 9216, 9218, 9220, 9222, 9224, 9226, 9228, 9230, 9232, 9234, 9236, 9238, 9240, 9242, 9244, 9246, 9248, 9250, 9252, 9254, 9256, 9258, 9260, 9262, 9264, 9266, 9268, 9270, 9272, 9274, 9276, 9278, 9280, 9282, 9284, 9286, 9288, 9290, 9292, 9294, 9296, 9298, 9300, 9302, 9304, 9306, 9308, 9310, 9312, 9314, 9316, 9318, 9320, 9322, 9324, 9326, 9328, 9330, 9332, 9334, 9336, 9338, 9340, 9342, 9344, 9346, 9348, 9350, 9352, 9354, 9356, 9358, 9360, 9362, 9364, 9366, 9368, 9370, 9372, 9374, 9376, 9378, 9380, 9382, 9384, 9386, 9388, 9390, 9392, 9394, 9396, 9398, 9400, 9402, 9404, 9406, 9408, 9410, 9412, 9414, 9416, 9418, 9420, 9422, 9424, 9426, 9428, 9430, 9432, 9434, 9436, 9438, 9440, 9442, 9444, 9446, 9448, 9450, 9452, 9454, 9456, 9458, 9460, 9462, 9464, 9466, 9468, 9470, 9472, 9474, 9476, 9478, 9480, 9482, 9484, 9486, 9488, 9490, 9492, 9494, 9496, 9498, 9500, 9502, 9504, 9506, 9508, 9510, 9512, 9514, 9516, 9518, 9520, 9522, 9524, 9526, 9528, 9530, 9532, 9534, 9536, 9538, 9540, 9542, 9544, 9546, 9548, 9550, 9552, 9554, 9556, 9558, 9560, 9562, 9564, 9566, 9568, 9570, 9572, 9574, 9576, 9578, 9580, 9582, 9584, 9586, 9588, 9590, 9592, 9594, 9596, 9598, 9600, 9602, 9604, 9606, 9608, 9610, 9612, 9614, 9616, 9618, 9620, 9622, 9624, 9626, 9628, 9630, 9632, 9634, 9636, 9638, 9640, 9642, 9644, 9646, 9648, 9650, 9652, 9654, 9656, 9658, 9660, 9662, 9664, 9666, 9668, 9670, 9672, 9674, 9676, 9678, 9680, 9682, 9684, 9686, 9688, 9690, 9692, 9694, 9696, 9698, 9700, 9702, 9704, 9706, 9708, 9710, 9712, 9714, 9716, 9718, 9720, 9722, 9724, 9726, 9728, 9730, 9732, 9734, 9736, 9738, 9740, 9742, 9744, 9746, 9748, 9750, 9752, 9754, 9756, 9758, 9760, 9762, 9764, 9766, 9768, 9770, 9772, 9774, 9776, 9778, 9780, 9782, 9784, 9786, 9788, 9790, 9792, 9794, 9796, 9798, 9800, 9802, 9804, 9806, 9808, 9810, 9812, 9814, 9816, 9818, 9820, 9822, 9824, 9826, 9828, 9830, 9832, 9834, 9836, 9838, 9840, 9842, 9844, 9846, 9848, 9850, 9852, 9854, 9856, 9858, 9860, 9862, 9864, 9866, 9868, 9870, 9872, 9874, 9876, 9878, 9880, 9882, 9884, 9886, 9888, 9890, 9892, 9894, 9896, 9898, 9900, 9902, 9904, 9906, 9908, 9910, 9912, 9914, 9916, 9918, 9920, 9922, 9924, 9926, 9928, 9930, 9932, 9934, 9936, 9938, 9940, 9942, 9944, 9946, 9948, 9950, 9952, 9954, 9956, 9958, 9960, 9962, 9964, 9966, 9968, 9970, 9972, 9974, 9976, 9978, 9980, 9982, 9984, 9986, 9988, 9990; (b) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) an amino acid sequence which is a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a); or (d) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a) and including a fragment of at least 10 consecutive amino acids from an amino acid sequence

CT/US06/05913
of (a). In a particular embodiment, the polypeptides of this aspect of the invention comprise a fragment which comprises at least one B-cell epitope of (a).

In a second aspect, the invention relates to a polypeptide comprising: (a) an amino acid sequence selected from the group consisting of SEQ ID NOs 512, 2454, 2456, 2678, 2692, 4596, 4748, 7004, 7052, 8168, 4628 and 5700; (b) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) an amino acid sequence which is a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a); or (d) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a) and including a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a). In a particular embodiment, the polypeptides of this aspect of the invention comprise a fragment which comprises at least one B-cell epitope of (a).

In another aspect, the invention relates to a polypeptide comprising: (a) an amino acid sequence selected from the group consisting of SEQ ID NOs 8564, 2728, 9872, 4672, 5680, 534, 3222, 3226 and 7004; (b) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) an amino acid sequence which is a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a); or (d) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a) and including a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a). In a particular embodiment, the polypeptides of this aspect of the invention comprise a fragment which comprises at least one B-cell epitope of (a).

The present invention also relates to a nucleic acid comprising: (a) a nucleotide sequence selected from the group consisting of SEQ ID NOs 705, 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227, 229, 231, 233, 235, 237, 239, 241, 243, 245, 247, 249, 251, 253, 255, 257, 259, 261, 263, 265, 267, 269, 271, 273, 275, 277, 279, 281, 283, 285, 287, 289, 291, 293, 295, 297, 299, 301, 303, 305, 307, 309, 311, 313, 315, 317, 319, 321, 323, 325, 327, 329, 331, 333, 335, 337, 339, 341, 343, 345, 347, 349, 351, 353, 355, 357, 359, 361, 363, 365, 367, 369, 371, 373, 375, 377, 379, 381, 383, 385, 387, 389, 391, 393, 395, 397, 399, 401, 403, 405, 407, 409, 411, 413, 415, 417, 419, 421, 423, 425, 427, 429, 431, 433, 435, 437, 439, 441, 443, 445, 447, 449, 451, 453, 455, 457, 459, 461, 463, 465, 467, 469, 471, 473, 475, 477, 479, 481, 483, 485, 487, 489, 491, 493, 495, 497, 499, 501, 503, 505, 507, 509, 511, 513, 515, 517, 519, 521, 523, 525, 527, 529, 531, 533, 535, 537, 539, 541, 543, 545, 547, 549, 551, 553, 555, 557, 559, 561, 563, 565, 567, 569, 571, 573, 575, 577, 579, 581, 583, 585, 587, 589, 591, 593, 595, 597, 599, 601, 603, 605, 607, 609,

PCT/US2006/005913
611, 613, 615, 617, 619, 621, 623, 625, 627, 629, 631, 633, 635, 637, 639, 641, 643, 645, 647, 649, 651, 653, 655, 657, 659, 661, 663, 665, 667, 669, 671, 673, 675, 677, 679, 681, 683, 685, 687, 689, 691, 693, 695, 697, 699, 701, 703, 707, 709, 711, 713, 715, 717, 719, 721, 723, 725, 727, 729, 731, 733, 735, 737, 739, 741, 743, 745, 747, 749, 751, 753, 755, 757, 759, 761, 763, 765, 767, 769, 771, 773, 775, 777, 779, 781, 783, 785, 787, 789, 791, 793, 795, 797, 799, 801, 803, 805, 807, 809, 811, 813, 815, 817, 819, 821, 823, 825, 827, 829, 831, 833, 835, 837, 839, 841, 843, 845, 847, 849, 851, 853, 855, 857, 859, 861, 863, 865, 867, 869, 871, 873, 875, 877, 879, 881, 883, 885, 887, 889, 891, 893, 895, 897, 899, 901, 903, 905, 907, 909, 911, 913, 915, 917, 919, 921, 923, 925, 927, 929, 931, 933, 935, 937, 939, 941, 943, 945, 947, 949, 951, 953, 955, 957, 959, 961, 963, 965, 967, 969, 971, 973, 975, 977, 979, 981, 983, 985, 987, 989, 991, 993, 995, 997, 999, 1001, 1003, 1005, 1007, 1009, 1011, 1013, 1015, 1017, 1019, 1021, 1023, 1025, 1027, 1029, 1031, 1033, 1035, 1037, 1039, 1041, 1043, 1045, 1047, 1049, 1051, 1053, 1055, 1057, 1059, 1061, 1063, 1065, 1067, 1069, 1071, 1073, 1075, 1077, 1079, 1081, 1083, 1085, 1087, 1089, 1091, 1093, 1095, 1097, 1099, 1101, 1103, 1105, 1107, 1109, 1111, 1113, 1115, 1117, 1119, 1121, 1123, 1125, 1127, 1129, 1131, 1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149, 1151, 1153, 1155, 1157, 1159, 1161, 1163, 1165, 1167, 1169, 1171, 1173, 1175, 1177, 1179, 1181, 1183, 1185, 1187, 1189, 1191, 1193, 1195, 1197, 1199, 1201, 1203, 1205, 1207, 1209, 1211, 1213, 1215, 1217, 1219, 1221, 1223, 1225, 1227, 1229, 1231, 1233, 1235, 1237, 1239, 1241, 1243, 1245, 1247, 1249, 1251, 1253, 1255, 1257, 1259, 1261, 1263, 1265, 1267, 1269, 1271, 1273, 1275, 1277, 1279, 1281, 1283, 1285, 1287, 1289, 1291, 1293, 1295, 1297, 1299, 1301, 1303, 1305, 1307, 1309, 1311, 1313, 1315, 1317, 1319, 1321, 1323, 1325, 1327, 1329, 1331, 1333, 1335, 1337, 1339, 1341, 1343, 1345, 1347, 1349, 1351, 1353, 1355, 1357, 1359, 1361, 1363, 1365, 1367, 1369, 1371, 1373, 1375, 1377, 1379, 1381, 1383, 1385, 1387, 1389, 1391, 1393, 1395, 1397, 1399, 1401, 1403, 1405, 1407, 1409, 1411, 1413, 1415, 1417, 1419, 1421, 1423, 1425, 1427, 1429, 1431, 1433, 1435, 1437, 1439, 1441, 1443, 1445, 1447, 1449, 1451, 1453, 1455, 1457, 1459, 1461, 1463, 1465, 1467, 1469, 1471, 1473, 1475, 1477, 1479, 1481, 1483, 1485, 1487, 1489, 1491, 1493, 1495, 1497, 1499, 1501, 1503, 1505, 1507, 1509, 1511, 1513, 1515, 1517, 1519, 1521, 1523, 1525, 1527, 1529, 1531, 1533, 1535, 1537, 1539, 1541, 1543, 1545, 1547, 1549, 1551, 1553, 1555, 1557, 1559, 1561, 1563, 1565, 1567, 1569, 1571, 1573, 1575, 1577, 1579, 1581, 1583, 1585, 1587, 1589, 1591, 1593, 1595, 1597, 1599, 1601, 1603, 1605, 1607, 1609, 1611, 1613, 1615, 1617, 1619, 1621, 1623, 1625, 1627, 1629, 1631, 1633, 1635, 1637, 1639, 1641, 1643, 1645, 1647, 1649, 1651, 1653, 1655, 1657, 1659, 1661, 1663, 1665, 1667, 1669, 1671, 1673, 1675, 1677, 1679, 1681, 1683, 1685, 1687, 1689, 1691, 1693, 1695, 1697, 1699, 1701, 1703, 1705, 1707, 1709, 1711, 1713, 1715, 1717, 1719, 1721, 1723, 1725, 1727, 1729, 1731, 1733, 1735, 1737, 1739, 1741, 1743, 1745, 1747, 1749, 1751, 1753, 1755, 1757, 1759, 1761, 1763, 1765, 1767, 1769, 1771, 1773, 1775, 1777, 1779, 1781, 1783, 1785, 1787, 1789, 1791, 1793, 1795, 1797, 1799, 1801, 1803, 1805, 1807, 1809, 1811, 1813, 1815, 1817, 1819, 1821, 1823, 1825, 1827, 1829, 1831, 1833, 1835, 1837, 1839, 1841, 1843, 1845, 1847, 1849, 1851, 1853, 1855, 1857, 1859, 1861, 1863, 1865, 1867, 1869, 1871, 1873, 1875, 1877, 1879, 1881, 1883, 1885, 1887, 1889, 1891, 1893, 1895, 1897, 1899, 1901, 1903, 1905,

PCT/US06/05913
1907, 1909, 1911, 1913, 1915, 1917, 1919, 1921, 1923, 1925, 1927, 1929, 1931, 1933, 1935, 1937, 1939, 1941, 1943, 1945, 1947, 1949, 1951, 1953, 1955, 1957, 1959, 1961, 1963, 1965, 1967, 1969, 1971, 1973, 1975, 1977, 1979, 1981, 1983, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021, 2023, 2025, 2027, 2029, 2031, 2033, 2035, 2037, 2039, 2041, 2043, 2045, 2047, 2049, 2051, 2053, 2055, 2057, 2059, 2061, 2063, 2065, 2067, 2069, 2071, 2073, 2075, 2077, 2079, 2081, 2083, 2085, 2087, 2089, 2091, 2093, 2095, 2097, 2099, 2101, 2103, 2105, 2107, 2109, 2111, 2113, 2115, 2117, 2119, 2121, 2123, 2125, 2127, 2129, 2131, 2133, 2135, 2137, 2139, 2141, 2143, 2145, 2147, 2149, 2151, 2153, 2155, 2157, 2159, 2161, 2163, 2165, 2167, 2169, 2171, 2173, 2175, 2177, 2179, 2181, 2183, 2185, 2187, 2189, 2191, 2193, 2195, 2197, 2199, 2201, 2203, 2205, 2207, 2209, 2211, 2213, 2215, 2217, 2219, 2221, 2223, 2225, 2227, 2229, 2231, 2233, 2235, 2237, 2239, 2241, 2243, 2245, 2247, 2249, 2251, 2253, 2255, 2257, 2259, 2261, 2263, 2265, 2267, 2269, 2271, 2273, 2275, 2277, 2279, 2281, 2283, 2285, 2287, 2289, 2291, 2293, 2295, 2297, 2299, 2301, 2303, 2305, 2307, 2309, 2311, 2313, 2315, 2317, 2319, 2321, 2323, 2325, 2327, 2329, 2331, 2333, 2335, 2337, 2339, 2341, 2343, 2345, 2347, 2349, 2351, 2353, 2355, 2357, 2359, 2361, 2363, 2365, 2367, 2369, 2371, 2373, 2375, 2377, 2379, 2381, 2383, 2385, 2387, 2389, 2391, 2393, 2395, 2397, 2399, 2401, 2403, 2405, 2407, 2409, 2411, 2413, 2415, 2417, 2419, 2421, 2423, 2425, 2427, 2429, 2431, 2433, 2435, 2437, 2439, 2441, 2443, 2445, 2447, 2449, 2451, 2453, 2455, 2457, 2459, 2461, 2463, 2465, 2467, 2469, 2471, 2473, 2475, 2477, 2479, 2481, 2483, 2485, 2487, 2489, 2491, 2493, 2495, 2497, 2499, 2501, 2503, 2505, 2507, 2509, 2511, 2513, 2515, 2517, 2519, 2521, 2523, 2525, 2527, 2529, 2531, 2533, 2535, 2537, 2539, 2541, 2543, 2545, 2547, 2549, 2551, 2553, 2555, 2557, 2559, 2561, 2563, 2565, 2567, 2569, 2571, 2573, 2575, 2577, 2579, 2581, 2583, 2585, 2587, 2589, 2591, 2593, 2595, 2597, 2599, 2601, 2603, 2605, 2607, 2609, 2611, 2613, 2615, 2617, 2619, 2621, 2623, 2625, 2627, 2629, 2631, 2633, 2635, 2637, 2639, 2641, 2643, 2645, 2647, 2649, 2651, 2653, 2655, 2657, 2659, 2661, 2663, 2665, 2667, 2669, 2671, 2673, 2675, 2677, 2679, 2681, 2683, 2685, 2687, 2689, 2691, 2693, 2695, 2697, 2699, 2701, 2703, 2705, 2707, 2709, 2711, 2713, 2715, 2717, 2719, 2721, 2723, 2725, 2727, 2729, 2731, 2733, 2735, 2737, 2739, 2741, 2743, 2745, 2747, 2749, 2751, 2753, 2755, 2757, 2759, 2761, 2763, 2765, 2767, 2769, 2771, 2773, 2775, 2777, 2779, 2781, 2783, 2785, 2787, 2789, 2791, 2793, 2795, 2797, 2799, 2801, 2803, 2805, 2807, 2809, 2811, 2813, 2815, 2817, 2819, 2821, 2823, 2825, 2827, 2829, 2831, 2833, 2835, 2837, 2839, 2841, 2843, 2845, 2847, 2849, 2851, 2853, 2855, 2857, 2859, 2861, 2863, 2865, 2867, 2869, 2871, 2873, 2875, 2877, 2879, 2881, 2883, 2885, 2887, 2889, 2891, 2893, 2895, 2897, 2899, 2901, 2903, 2905, 2907, 2909, 2911, 2913, 2915, 2917, 2919, 2921, 2923, 2925, 2927, 2929, 2931, 2933, 2935, 2937, 2939, 2941, 2943, 2945, 2947, 2949, 2951, 2953, 2955, 2957, 2959, 2961, 2963, 2965, 2967, 2969, 2971, 2973, 2975, 2977, 2979, 2981, 2983, 2985, 2987, 2989, 2991, 2993, 2995, 2997, 2999, 3001, 3003, 3005, 3007, 3009, 3011, 3013, 3015, 3017, 3019, 3021, 3023, 3025, 3027, 3029, 3031, 3033, 3035, 3037, 3039, 3041, 3043, 3045, 3047, 3049, 3051, 3053, 3055, 3057, 3059, 3061, 3063, 3065, 3067, 3069, 3071, 3073, 3075, 3077, 3079, 3081, 3083, 3085, 3087, 3089, 3091, 3093, 3095, 3097, 3099, 3101, 3103, 3105, 3107, 3109, 3111, 3113, 3115, 3117, 3119, 3121,

CT/US06/05913

3123, 3125, 3127, 3129, 3131, 3133, 3135, 3137, 3139, 3141, 3143, 3145, 3147, 3149, 3151, 3153, 3155, 3157, 3159, 3161, 3163, 3165, 3167, 3169, 3171, 3173, 3175, 3177, 3179, 3181, 3183, 3185, 3187, 3189, 3191, 3193, 3195, 3197, 3199, 3201, 3203, 3205, 3207, 3209, 3211, 3213, 3215, 3217, 3219, 3221, 3223, 3225, 3227, 3229, 3231, 3233, 3235, 3237, 3239, 3241, 3243, 3245, 3247, 3249, 3251, 3253, 3255, 3257, 3259, 3261, 3263, 3265, 3267, 3269, 3271, 3273, 3275, 3277, 3279, 3281, 3283, 3285, 3287, 3289, 3291, 3293, 3295, 3297, 3299, 3301, 3303, 3305, 3307, 3309, 3311, 3313, 3315, 3317, 3319, 3321, 3323, 3325, 3327, 3329, 3331, 3333, 3335, 3337, 3339, 3341, 3343, 3345, 3347, 3349, 3351, 3353, 3355, 3357, 3359, 3361, 3363, 3365, 3367, 3369, 3371, 3373, 3375, 3377, 3379, 3381, 3383, 3385, 3387, 3389, 3391, 3393, 3395, 3397, 3399, 3401, 3403, 3405, 3407, 3409, 3411, 3413, 3415, 3417, 3419, 3421, 3423, 3425, 3427, 3429, 3431, 3433, 3435, 3437, 3439, 3441, 3443, 3445, 3447, 3449, 3451, 3453, 3455, 3457, 3459, 3461, 3463, 3465, 3467, 3469, 3471, 3473, 3475, 3477, 3479, 3481, 3483, 3485, 3487, 3489, 3491, 3493, 3495, 3497, 3499, 3501, 3503, 3505, 3507, 3509, 3511, 3513, 3515, 3517, 3519, 3521, 3523, 3525, 3527, 3529, 3531, 3533, 3535, 3537, 3539, 3541, 3543, 3545, 3547, 3549, 3551, 3553, 3555, 3557, 3559, 3561, 3563, 3565, 3567, 3569, 3571, 3573, 3575, 3577, 3579, 3581, 3583, 3585, 3587, 3589, 3591, 3593, 3595, 3597, 3599, 3601, 3603, 3605, 3607, 3609, 3611, 3613, 3615, 3617, 3619, 3621, 3623, 3625, 3627, 3629, 3631, 3633, 3635, 3637, 3639, 3641, 3643, 3645, 3647, 3649, 3651, 3653, 3655, 3657, 3659, 3661, 3663, 3665, 3667, 3669, 3671, 3673, 3675, 3677, 3679, 3681, 3683, 3685, 3687, 3689, 3691, 3693, 3695, 3697, 3699, 3701, 3703, 3705, 3707, 3709, 3711, 3713, 3715, 3717, 3719, 3721, 3723, 3725, 3727, 3729, 3731, 3733, 3735, 3737, 3739, 3741, 3743, 3745, 3747, 3749, 3751, 3753, 3755, 3757, 3759, 3761, 3763, 3765, 3767, 3769, 3771, 3773, 3775, 3777, 3779, 3781, 3783, 3785, 3787, 3789, 3791, 3793, 3795, 3797, 3799, 3801, 3803, 3805, 3807, 3809, 3811, 3813, 3815, 3817, 3819, 3821, 3823, 3825, 3827, 3829, 3831, 3833, 3835, 3837, 3839, 3841, 3843, 3845, 3847, 3849, 3851, 3853, 3855, 3857, 3859, 3861, 3863, 3865, 3867, 3869, 3871, 3873, 3875, 3877, 3879, 3881, 3883, 3885, 3887, 3889, 3891, 3893, 3895, 3897, 3899, 3901, 3903, 3905, 3907, 3909, 3911, 3913, 3915, 3917, 3919, 3921, 3923, 3925, 3927, 3929, 3931, 3933, 3935, 3937, 3939, 3941, 3943, 3945, 3947, 3949, 3951, 3953, 3955, 3957, 3959, 3961, 3963, 3965, 3967, 3969, 3971, 3973, 3975, 3977, 3979, 3981, 3983, 3985, 3987, 3989, 3991, 3993, 3995, 3997, 3999, 4001, 4003, 4005, 4007, 4009, 4011, 4013, 4015, 4017, 4019, 4021, 4023, 4025, 4027, 4029, 4031, 4033, 4035, 4037, 4039, 4041, 4043, 4045, 4047, 4049, 4051, 4053, 4055, 4057, 4059, 4061, 4063, 4065, 4067, 4069, 4071, 4073, 4075, 4077, 4079, 4081, 4083, 4085, 4087, 4089, 4091, 4093, 4095, 4097, 4099, 4101, 4103, 4105, 4107, 4109, 4111, 4113, 4115, 4117, 4119, 4121, 4123, 4125, 4127, 4129, 4131, 4133, 4135, 4137, 4139, 4141, 4143, 4145, 4147, 4149, 4151, 4153, 4155, 4157, 4159, 4161, 4163, 4165, 4167, 4169, 4171, 4173, 4175, 4177, 4179, 4181, 4183, 4185, 4187, 4189, 4191, 4193, 4195, 4197, 4199, 4201, 4203, 4205, 4207, 4209, 4211, 4213, 4215, 4217, 4219, 4221, 4223, 4225, 4227, 4229, 4231, 4233, 4235, 4237, 4239, 4241, 4243, 4245, 4247, 4249, 4251, 4253, 4255, 4257, 4259, 4261, 4263, 4265, 4267, 4269, 4271, 4273, 4275, 4277, 4279, 4281, 4283, 4285, 4287, 4289, 4291, 4293, 4295, 4297, 4299, 4301, 4303, 4305, 4307, 4309, 4311, 4313, 4315, 4317, 4319, 4321, 4323, 4325, 4327, 4329, 4331, 4333, 4335, 4337,

4339, 4341, 4343, 4345, 4347, 4349, 4351, 4353, 4355, 4357, 4359, 4361, 4363, 4365, 4367, 4369, 4371, 4373, 4375, 4377, 4379, 4381, 4383, 4385, 4387, 4389, 4391, 4393, 4395, 4397, 4399, 4401, 4403, 4405, 4407, 4409, 4411, 4413, 4415, 4417, 4419, 4421, 4423, 4425, 4427, 4429, 4431, 4433, 4435, 4437, 4439, 4441, 4443, 4445, 4447, 4449, 4451, 4453, 4455, 4457, 4459, 4461, 4463, 4465, 4467, 4469, 4471, 4473, 4475, 4477, 4479, 4481, 4483, 4485, 4487, 4489, 4491, 4493, 4495, 4497, 4499, 4501, 4503, 4505, 4507, 4509, 4511, 4513, 4515, 4517, 4519, 4521, 4523, 4525, 4527, 4529, 4531, 4533, 4535, 4537, 4539, 4541, 4543, 4545, 4547, 4549, 4551, 4553, 4555, 4557, 4559, 4561, 4563, 4565, 4567, 4569, 4571, 4573, 4575, 4577, 4579, 4581, 4583, 4585, 4587, 4589, 4591, 4593, 4595, 4597, 4599, 4601, 4603, 4605, 4607, 4609, 4611, 4613, 4615, 4617, 4619, 4621, 4623, 4625, 4627, 4629, 4631, 4633, 4635, 4637, 4639, 4641, 4643, 4645, 4647, 4649, 4651, 4653, 4655, 4657, 4659, 4661, 4663, 4665, 4667, 4669, 4671, 4673, 4675, 4677, 4679, 4681, 4683, 4685, 4687, 4689, 4691, 4693, 4695, 4697, 4699, 4701, 4703, 4705, 4707, 4709, 4711, 4713, 4715, 4717, 4719, 4721, 4723, 4725, 4727, 4729, 4731, 4733, 4735, 4737, 4739, 4741, 4743, 4745, 4747, 4749, 4751, 4753, 4755, 4757, 4759, 4761, 4763, 4765, 4767, 4769, 4771, 4773, 4775, 4777, 4779, 4781, 4783, 4785, 4787, 4789, 4791, 4793, 4795, 4797, 4799, 4801, 4803, 4805, 4807, 4809, 4811, 4813, 4815, 4817, 4819, 4821, 4823, 4825, 4827, 4829, 4831, 4833, 4835, 4837, 4839, 4841, 4843, 4845, 4847, 4849, 4851, 4853, 4855, 4857, 4859, 4861, 4863, 4865, 4867, 4869, 4871, 4873, 4875, 4877, 4879, 4881, 4883, 4885, 4887, 4889, 4891, 4893, 4895, 4897, 4899, 4901, 4903, 4905, 4907, 4909, 4911, 4913, 4915, 4917, 4919, 4921, 4923, 4925, 4927, 4929, 4931, 4933, 4935, 4937, 4939, 4941, 4943, 4945, 4947, 4949, 4951, 4953, 4955, 4957, 4959, 4961, 4963, 4965, 4967, 4969, 4971, 4973, 4975, 4977, 4979, 4981, 4983, 4985, 4987, 4989, 4991, 4993, 4995, 4997, 4999, 5001, 5003, 5005, 5007, 5009, 5011, 5013, 5015, 5017, 5019, 5021, 5023, 5025, 5027, 5029, 5031, 5033, 5035, 5037, 5039, 5041, 5043, 5045, 5047, 5049, 5051, 5053, 5055, 5057, 5059, 5061, 5063, 5065, 5067, 5069, 5071, 5073, 5075, 5077, 5079, 5081, 5083, 5085, 5087, 5089, 5091, 5093, 5095, 5097, 5099, 5101, 5103, 5105, 5107, 5109, 5111, 5113, 5115, 5117, 5119, 5121, 5123, 5125, 5127, 5129, 5131, 5133, 5135, 5137, 5139, 5141, 5143, 5145, 5147, 5149, 5151, 5153, 5155, 5157, 5159, 5161, 5163, 5165, 5167, 5169, 5171, 5173, 5175, 5177, 5179, 5181, 5183, 5185, 5187, 5189, 5191, 5193, 5195, 5197, 5199, 5201, 5203, 5205, 5207, 5209, 5211, 5213, 5215, 5217, 5219, 5221, 5223, 5225, 5227, 5229, 5231, 5233, 5235, 5237, 5239, 5241, 5243, 5245, 5247, 5249, 5251, 5253, 5255, 5257, 5259, 5261, 5263, 5265, 5267, 5269, 5271, 5273, 5275, 5277, 5279, 5281, 5283, 5285, 5287, 5289, 5291, 5293, 5295, 5297, 5299, 5301, 5303, 5305, 5307, 5309, 5311, 5313, 5315, 5317, 5319, 5321, 5323, 5325, 5327, 5329, 5331, 5333, 5335, 5337, 5339, 5341, 5343, 5345, 5347, 5349, 5351, 5353, 5355, 5357, 5359, 5361, 5363, 5365, 5367, 5369, 5371, 5373, 5375, 5377, 5379, 5381, 5383, 5385, 5387, 5389, 5391, 5393, 5395, 5397, 5399, 5401, 5403, 5405, 5407, 5409, 5411, 5413, 5415, 5417, 5419, 5421, 5423, 5425, 5427, 5429, 5431, 5433, 5435, 5437, 5439, 5441, 5443, 5445, 5447, 5449, 5451, 5453, 5455, 5457, 5459, 5461, 5463, 5465, 5467, 5469, 5471, 5473, 5475, 5477, 5479, 5481, 5483, 5485, 5487, 5489, 5491, 5493, 5495, 5497, 5499, 5501, 5503, 5505, 5507, 5509, 5511, 5513, 5515, 5517, 5519, 5521, 5523, 5525, 5527, 5529, 5531, 5533, 5535, 5537, 5539, 5541, 5543, 5545, 5547, 5549, 5551, 5553,

5555, 5557, 5559, 5561, 5563, 5565, 5567, 5569, 5571, 5573, 5575, 5577, 5579, 5581, 5583, 5585, 5587, 5589, 5591, 5593, 5595, 5597, 5599, 5601, 5603, 5605, 5607, 5609, 5611, 5613, 5615, 5617, 5619, 5621, 5623, 5625, 5627, 5629, 5631, 5633, 5635, 5637, 5639, 5641, 5643, 5645, 5647, 5649, 5651, 5653, 5655, 5657, 5659, 5661, 5663, 5665, 5667, 5669, 5671, 5673, 5675, 5677, 5679, 5681, 5683, 5685, 5687, 5689, 5691, 5693, 5695, 5697, 5699, 5701, 5703, 5705, 5707, 5709, 5711, 5713, 5715, 5717, 5719, 5721, 5723, 5725, 5727, 5729, 5731, 5733, 5735, 5737, 5739, 5741, 5743, 5745, 5747, 5749, 5751, 5753, 5755, 5757, 5759, 5761, 5763, 5765, 5767, 5769, 5771, 5773, 5775, 5777, 5779, 5781, 5783, 5785, 5787, 5789, 5791, 5793, 5795, 5797, 5799, 5801, 5803, 5805, 5807, 5809, 5811, 5813, 5815, 5817, 5819, 5821, 5823, 5825, 5827, 5829, 5831, 5833, 5835, 5837, 5839, 5841, 5843, 5845, 5847, 5849, 5851, 5853, 5855, 5857, 5859, 5861, 5863, 5865, 5867, 5869, 5871, 5873, 5875, 5877, 5879, 5881, 5883, 5885, 5887, 5889, 5891, 5893, 5895, 5897, 5899, 5901, 5903, 5905, 5907, 5909, 5911, 5913, 5915, 5917, 5919, 5921, 5923, 5925, 5927, 5929, 5931, 5933, 5935, 5937, 5939, 5941, 5943, 5945, 5947, 5949, 5951, 5953, 5955, 5957, 5959, 5961, 5963, 5965, 5967, 5969, 5971, 5973, 5975, 5977, 5979, 5981, 5983, 5985, 5987, 5989, 5991, 5993, 5995, 5997, 5999, 6001, 6003, 6005, 6007, 6009, 6011, 6013, 6015, 6017, 6019, 6021, 6023, 6025, 6027, 6029, 6031, 6033, 6035, 6037, 6039, 6041, 6043, 6045, 6047, 6049, 6051, 6053, 6055, 6057, 6059, 6061, 6063, 6065, 6067, 6069, 6071, 6073, 6075, 6077, 6079, 6081, 6083, 6085, 6087, 6089, 6091, 6093, 6095, 6097, 6099, 6101, 6103, 6105, 6107, 6109, 6111, 6113, 6115, 6117, 6119, 6121, 6123, 6125, 6127, 6129, 6131, 6133, 6135, 6137, 6139, 6141, 6143, 6145, 6147, 6149, 6151, 6153, 6155, 6157, 6159, 6161, 6163, 6165, 6167, 6169, 6171, 6173, 6175, 6177, 6179, 6181, 6183, 6185, 6187, 6189, 6191, 6193, 6195, 6197, 6199, 6201, 6203, 6205, 6207, 6209, 6211, 6213, 6215, 6217, 6219, 6221, 6223, 6225, 6227, 6229, 6231, 6233, 6235, 6237, 6239, 6241, 6243, 6245, 6247, 6249, 6251, 6253, 6255, 6257, 6259, 6261, 6263, 6265, 6267, 6269, 6271, 6273, 6275, 6277, 6279, 6281, 6283, 6285, 6287, 6289, 6291, 6293, 6295, 6297, 6299, 6301, 6303, 6305, 6307, 6309, 6311, 6313, 6315, 6317, 6319, 6321, 6323, 6325, 6327, 6329, 6331, 6333, 6335, 6337, 6339, 6341, 6343, 6345, 6347, 6349, 6351, 6353, 6355, 6357, 6359, 6361, 6363, 6365, 6367, 6369, 6371, 6373, 6375, 6377, 6379, 6381, 6383, 6385, 6387, 6389, 6391, 6393, 6395, 6397, 6399, 6401, 6403, 6405, 6407, 6409, 6411, 6413, 6415, 6417, 6419, 6421, 6423, 6425, 6427, 6429, 6431, 6433, 6435, 6437, 6439, 6441, 6443, 6445, 6447, 6449, 6451, 6453, 6455, 6457, 6459, 6461, 6463, 6465, 6467, 6469, 6471, 6473, 6475, 6477, 6479, 6481, 6483, 6485, 6487, 6489, 6491, 6493, 6495, 6497, 6499, 6501, 6503, 6505, 6507, 6509, 6511, 6513, 6515, 6517, 6519, 6521, 6523, 6525, 6527, 6529, 6531, 6533, 6535, 6537, 6539, 6541, 6543, 6545, 6547, 6549, 6551, 6553, 6555, 6557, 6559, 6561, 6563, 6565, 6567, 6569, 6571, 6573, 6575, 6577, 6579, 6581, 6583, 6585, 6587, 6589, 6591, 6593, 6595, 6597, 6599, 6601, 6603, 6605, 6607, 6609, 6611, 6613, 6615, 6617, 6619, 6621, 6623, 6625, 6627, 6629, 6631, 6633, 6635, 6637, 6639, 6641, 6643, 6645, 6647, 6649, 6651, 6653, 6655, 6657, 6659, 6661, 6663, 6665, 6667, 6669, 6671, 6673, 6675, 6677, 6679, 6681, 6683, 6685, 6687, 6689, 6691, 6693, 6695, 6697, 6699, 6701, 6703, 6705, 6707, 6709, 6711, 6713, 6715, 6717, 6719, 6721, 6723, 6725, 6727, 6729, 6731, 6733, 6735, 6737, 6739, 6741, 6743, 6745, 6747, 6749, 6751, 6753, 6755, 6757, 6759, 6761, 6763, 6765, 6767, 6769,

6771, 6773, 6775, 6777, 6779, 6781, 6783, 6785, 6787, 6789, 6791, 6793, 6795, 6797, 6799, 6801, 6803, 6805, 6807, 6809, 6811, 6813, 6815, 6817, 6819, 6821, 6823, 6825, 6827, 6829, 6831, 6833, 6835, 6837, 6839, 6841, 6843, 6845, 6847, 6849, 6851, 6853, 6855, 6857, 6859, 6861, 6863, 6865, 6867, 6869, 6871, 6873, 6875, 6877, 6879, 6881, 6883, 6885, 6887, 6889, 6891, 6893, 6895, 6897, 6899, 6901, 6903, 6905, 6907, 6909, 6911, 6913, 6915, 6917, 6919, 6921, 6923, 6925, 6927, 6929, 6931, 6933, 6935, 6937, 6939, 6941, 6943, 6945, 6947, 6949, 6951, 6953, 6955, 6957, 6959, 6961, 6963, 6965, 6967, 6969, 6971, 6973, 6975, 6977, 6979, 6981, 6983, 6985, 6987, 6989, 6991, 6993, 6995, 6997, 6999, 7001, 7003, 7005, 7007, 7009, 7011, 7013, 7015, 7017, 7019, 7021, 7023, 7025, 7027, 7029, 7031, 7033, 7035, 7037, 7039, 7041, 7043, 7045, 7047, 7049, 7051, 7053, 7055, 7057, 7059, 7061, 7063, 7065, 7067, 7069, 7071, 7073, 7075, 7077, 7079, 7081, 7083, 7085, 7087, 7089, 7091, 7093, 7095, 7097, 7099, 7101, 7103, 7105, 7107, 7109, 7111, 7113, 7115, 7117, 7119, 7121, 7123, 7125, 7127, 7129, 7131, 7133, 7135, 7137, 7139, 7141, 7143, 7145, 7147, 7149, 7151, 7153, 7155, 7157, 7159, 7161, 7163, 7165, 7167, 7169, 7171, 7173, 7175, 7177, 7179, 7181, 7183, 7185, 7187, 7189, 7191, 7193, 7195, 7197, 7199, 7201, 7203, 7205, 7207, 7209, 7211, 7213, 7215, 7217, 7219, 7221, 7223, 7225, 7227, 7229, 7231, 7233, 7235, 7237, 7239, 7241, 7243, 7245, 7247, 7249, 7251, 7253, 7255, 7257, 7259, 7261, 7263, 7265, 7267, 7269, 7271, 7273, 7275, 7277, 7279, 7281, 7283, 7285, 7287, 7289, 7291, 7293, 7295, 7297, 7299, 7301, 7303, 7305, 7307, 7309, 7311, 7313, 7315, 7317, 7319, 7321, 7323, 7325, 7327, 7329, 7331, 7333, 7335, 7337, 7339, 7341, 7343, 7345, 7347, 7349, 7351, 7353, 7355, 7357, 7359, 7361, 7363, 7365, 7367, 7369, 7371, 7373, 7375, 7377, 7379, 7381, 7383, 7385, 7387, 7389, 7391, 7393, 7395, 7397, 7399, 7401, 7403, 7405, 7407, 7409, 7411, 7413, 7415, 7417, 7419, 7421, 7423, 7425, 7427, 7429, 7431, 7433, 7435, 7437, 7439, 7441, 7443, 7445, 7447, 7449, 7451, 7453, 7455, 7457, 7459, 7461, 7463, 7465, 7467, 7469, 7471, 7473, 7475, 7477, 7479, 7481, 7483, 7485, 7487, 7489, 7491, 7493, 7495, 7497, 7499, 7501, 7503, 7505, 7507, 7509, 7511, 7513, 7515, 7517, 7519, 7521, 7523, 7525, 7527, 7529, 7531, 7533, 7535, 7537, 7539, 7541, 7543, 7545, 7547, 7549, 7551, 7553, 7555, 7557, 7559, 7561, 7563, 7565, 7567, 7569, 7571, 7573, 7575, 7577, 7579, 7581, 7583, 7585, 7587, 7589, 7591, 7593, 7595, 7597, 7599, 7601, 7603, 7605, 7607, 7609, 7611, 7613, 7615, 7617, 7619, 7621, 7623, 7625, 7627, 7629, 7631, 7633, 7635, 7637, 7639, 7641, 7643, 7645, 7647, 7649, 7651, 7653, 7655, 7657, 7659, 7661, 7663, 7665, 7667, 7669, 7671, 7673, 7675, 7677, 7679, 7681, 7683, 7685, 7687, 7689, 7691, 7693, 7695, 7697, 7699, 7701, 7703, 7705, 7707, 7709, 7711, 7713, 7715, 7717, 7719, 7721, 7723, 7725, 7727, 7729, 7731, 7733, 7735, 7737, 7739, 7741, 7743, 7745, 7747, 7749, 7751, 7753, 7755, 7757, 7759, 7761, 7763, 7765, 7767, 7769, 7771, 7773, 7775, 7777, 7779, 7781, 7783, 7785, 7787, 7789, 7791, 7793, 7795, 7797, 7799, 7801, 7803, 7805, 7807, 7809, 7811, 7813, 7815, 7817, 7819, 7821, 7823, 7825, 7827, 7829, 7831, 7833, 7835, 7837, 7839, 7841, 7843, 7845, 7847, 7849, 7851, 7853, 7855, 7857, 7859, 7861, 7863, 7865, 7867, 7869, 7871, 7873, 7875, 7877, 7879, 7881, 7883, 7885, 7887, 7889, 7891, 7893, 7895, 7897, 7899, 7901, 7903, 7905, 7907, 7909, 7911, 7913, 7915, 7917, 7919, 7921, 7923, 7925, 7927, 7929, 7931, 7933, 7935, 7937, 7939, 7941, 7943, 7945, 7947, 7949, 7951, 7953, 7955, 7957, 7959, 7961, 7963, 7965, 7967, 7969, 7971, 7973, 7975, 7977, 7979, 7981, 7983, 7985,

CT/US06/05913
7987, 7989, 7991, 7993, 7995, 7997, 7999, 8001, 8003, 8005, 8007, 8009, 8011, 8013, 8015, 8017, 8019, 8021, 8023, 8025, 8027, 8029, 8031, 8033, 8035, 8037, 8039, 8041, 8043, 8045, 8047, 8049, 8051, 8053, 8055, 8057, 8059, 8061, 8063, 8065, 8067, 8069, 8071, 8073, 8075, 8077, 8079, 8081, 8083, 8085, 8087, 8089, 8091, 8093, 8095, 8097, 8099, 8101, 8103, 8105, 8107, 8109, 8111, 8113, 8115, 8117, 8119, 8121, 8123, 8125, 8127, 8129, 8131, 8133, 8135, 8137, 8139, 8141, 8143, 8145, 8147, 8149, 8151, 8153, 8155, 8157, 8159, 8161, 8163, 8165, 8167, 8169, 8171, 8173, 8175, 8177, 8179, 8181, 8183, 8185, 8187, 8189, 8191, 8193, 8195, 8197, 8199, 8201, 8203, 8205, 8207, 8209, 8211, 8213, 8215, 8217, 8219, 8221, 8223, 8225, 8227, 8229, 8231, 8233, 8235, 8237, 8239, 8241, 8243, 8245, 8247, 8249, 8251, 8253, 8255, 8257, 8259, 8261, 8263, 8265, 8267, 8269, 8271, 8273, 8275, 8277, 8279, 8281, 8283, 8285, 8287, 8289, 8291, 8293, 8295, 8297, 8299, 8301, 8303, 8305, 8307, 8309, 8311, 8313, 8315, 8317, 8319, 8321, 8323, 8325, 8327, 8329, 8331, 8333, 8335, 8337, 8339, 8341, 8343, 8345, 8347, 8349, 8351, 8353, 8355, 8357, 8359, 8361, 8363, 8365, 8367, 8369, 8371, 8373, 8375, 8377, 8379, 8381, 8383, 8385, 8387, 8389, 8391, 8393, 8395, 8397, 8399, 8401, 8403, 8405, 8407, 8409, 8411, 8413, 8415, 8417, 8419, 8421, 8423, 8425, 8427, 8429, 8431, 8433, 8435, 8437, 8439, 8441, 8443, 8445, 8447, 8449, 8451, 8453, 8455, 8457, 8459, 8461, 8463, 8465, 8467, 8469, 8471, 8473, 8475, 8477, 8479, 8481, 8483, 8485, 8487, 8489, 8491, 8493, 8495, 8497, 8499, 8501, 8503, 8505, 8507, 8509, 8511, 8513, 8515, 8517, 8519, 8521, 8523, 8525, 8527, 8529, 8531, 8533, 8535, 8537, 8539, 8541, 8543, 8545, 8547, 8549, 8551, 8553, 8555, 8557, 8559, 8561, 8563, 8565, 8567, 8569, 8571, 8573, 8575, 8577, 8579, 8581, 8583, 8585, 8587, 8589, 8591, 8593, 8595, 8597, 8599, 8601, 8603, 8605, 8607, 8609, 8611, 8613, 8615, 8617, 8619, 8621, 8623, 8625, 8627, 8629, 8631, 8633, 8635, 8637, 8639, 8641, 8643, 8645, 8647, 8649, 8651, 8653, 8655, 8657, 8659, 8661, 8663, 8665, 8667, 8669, 8671, 8673, 8675, 8677, 8679, 8681, 8683, 8685, 8687, 8689, 8691, 8693, 8695, 8697, 8699, 8701, 8703, 8705, 8707, 8709, 8711, 8713, 8715, 8717, 8719, 8721, 8723, 8725, 8727, 8729, 8731, 8733, 8735, 8737, 8739, 8741, 8743, 8745, 8747, 8749, 8751, 8753, 8755, 8757, 8759, 8761, 8763, 8765, 8767, 8769, 8771, 8773, 8775, 8777, 8779, 8781, 8783, 8785, 8787, 8789, 8791, 8793, 8795, 8797, 8799, 8801, 8803, 8805, 8807, 8809, 8811, 8813, 8815, 8817, 8819, 8821, 8823, 8825, 8827, 8829, 8831, 8833, 8835, 8837, 8839, 8841, 8843, 8845, 8847, 8849, 8851, 8853, 8855, 8857, 8859, 8861, 8863, 8865, 8867, 8869, 8871, 8873, 8875, 8877, 8879, 8881, 8883, 8885, 8887, 8889, 8891, 8893, 8895, 8897, 8899, 8901, 8903, 8905, 8907, 8909, 8911, 8913, 8915, 8917, 8919, 8921, 8923, 8925, 8927, 8929, 8931, 8933, 8935, 8937, 8939, 8941, 8943, 8945, 8947, 8949, 8951, 8953, 8955, 8957, 8959, 8961, 8963, 8965, 8967, 8969, 8971, 8973, 8975, 8977, 8979, 8981, 8983, 8985, 8987, 8989, 8991, 8993, 8995, 8997, 8999, 9001, 9003, 9005, 9007, 9009, 9011, 9013, 9015, 9017, 9019, 9021, 9023, 9025, 9027, 9029, 9031, 9033, 9035, 9037, 9039, 9041, 9043, 9045, 9047, 9049, 9051, 9053, 9055, 9057, 9059, 9061, 9063, 9065, 9067, 9069, 9071, 9073, 9075, 9077, 9079, 9081, 9083, 9085, 9087, 9089, 9091, 9093, 9095, 9097, 9099, 9101, 9103, 9105, 9107, 9109, 9111, 9113, 9115, 9117, 9119, 9121, 9123, 9125, 9127, 9129, 9131, 9133, 9135, 9137, 9139, 9141, 9143, 9145, 9147, 9149, 9151, 9153, 9155, 9157, 9159, 9161, 9163, 9165, 9167, 9169, 9171, 9173, 9175, 9177, 9179, 9181, 9183, 9185, 9187, 9189, 9191, 9193, 9195, 9197, 9199, 9201,

9203, 9205, 9207, 9209, 9211, 9213, 9215, 9217, 9219, 9221, 9223, 9225, 9227, 9229, 9231, 9233, 9235, 9237, 9239, 9241, 9243, 9245, 9247, 9249, 9251, 9253, 9255, 9257, 9259, 9261, 9263, 9265, 9267, 9269, 9271, 9273, 9275, 9277, 9279, 9281, 9283, 9285, 9287, 9289, 9291, 9293, 9295, 9297, 9299, 9301, 9303, 9305, 9307, 9309, 9311, 9313, 9315, 9317, 9319, 9321, 9323, 9325, 9327, 9329, 9331, 9333, 9335, 9337, 9339, 9341, 9343, 9345, 9347, 9349, 9351, 9353, 9355, 9357, 9359, 9361, 9363, 9365, 9367, 9369, 9371, 9373, 9375, 9377, 9379, 9381, 9383, 9385, 9387, 9389, 9391, 9393, 9395, 9397, 9399, 9401, 9403, 9405, 9407, 9409, 9411, 9413, 9415, 9417, 9419, 9421, 9423, 9425, 9427, 9429, 9431, 9433, 9435, 9437, 9439, 9441, 9443, 9445, 9447, 9449, 9451, 9453, 9455, 9457, 9459, 9461, 9463, 9465, 9467, 9469, 9471, 9473, 9475, 9477, 9479, 9481, 9483, 9485, 9487, 9489, 9491, 9493, 9495, 9497, 9499, 9501, 9503, 9505, 9507, 9509, 9511, 9513, 9515, 9517, 9519, 9521, 9523, 9525, 9527, 9529, 9531, 9533, 9535, 9537, 9539, 9541, 9543, 9545, 9547, 9549, 9551, 9553, 9555, 9557, 9559, 9561, 9563, 9565, 9567, 9569, 9571, 9573, 9575, 9577, 9579, 9581, 9583, 9585, 9587, 9589, 9591, 9593, 9595, 9597, 9599, 9601, 9603, 9605, 9607, 9609, 9611, 9613, 9615, 9617, 9619, 9621, 9623, 9625, 9627, 9629, 9631, 9633, 9635, 9637, 9639, 9641, 9643, 9645, 9647, 9649, 9651, 9653, 9655, 9657, 9659, 9661, 9663, 9665, 9667, 9669, 9671, 9673, 9675, 9677, 9679, 9681, 9683, 9685, 9687, 9689, 9691, 9693, 9695, 9697, 9699, 9701, 9703, 9705, 9707, 9709, 9711, 9713, 9715, 9717, 9719, 9721, 9723, 9725, 9727, 9729, 9731, 9733, 9735, 9737, 9739, 9741, 9743, 9745, 9747, 9749, 9751, 9753, 9755, 9757, 9759, 9761, 9763, 9765, 9767, 9769, 9771, 9773, 9775, 9777, 9779, 9781, 9783, 9785, 9787, 9789, 9791, 9793, 9795, 9797, 9799, 9801, 9803, 9805, 9807, 9809, 9811, 9813, 9815, 9817, 9819, 9821, 9823, 9825, 9827, 9829, 9831, 9833, 9835, 9837, 9839, 9841, 9843, 9845, 9847, 9849, 9851, 9853, 9855, 9857, 9859, 9861, 9863, 9865, 9867, 9869, 9871, 9873, 9875, 9877, 9879, 9881, 9883, 9885, 9887, 9889, 9891, 9893, 9895, 9897, 9899, 9901, 9903, 9905, 9907, 9909, 9911, 9913, 9915, 9917, 9919, 9921, 9923, 9925, 9927, 9929, 9931, 9933, 9935, 9937, 9939, 9941, 9943, 9945, 9947, 9949, 9951, 9953, 9955, 9957, 9959, 9961, 9963, 9965, 9967, 9969, 9971, 9973, 9975, 9977, 9979, 9981, 9983, 9985, 9987, 9989; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

In another aspect, the invention relates to a nucleic acid comprising: (a) a nucleotide sequence selected from the group consisting of SEQ ID NOs 511, 2453, 2455, 2677, 2691, 4595, 4747, 7003, 7051, 8167, 4627 and 5699; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

In a further aspect, the invention relates to a nucleic acid comprising: (a) a nucleotide sequence selected from the group consisting of SEQ ID Nos 8563, 2727, 9871, 4671, 5679, 533, 3221, 3225

and 7003; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

The present invention also relates to nucleic acids of the invention encoding a polypeptide the invention, and to monoclonal antibodies specific for a polypeptide of the invention.

The polypeptides, nucleic acids and antibodies of the invention can be used in medicine and in the manufacture of a medicament for raising an immune response in a patient.

The present invention also relates to pharmaceutical compositions comprising a polypeptide, nucleic acid or antibody of the invention, in admixture with a pharmaceutically acceptable carrier. The invention further relates to a pharmaceutical composition comprising two or more polypeptides of the invention, in admixture with a pharmaceutically acceptable carrier. In a particular embodiment, the pharmaceutical compositions of the invention further comprise a vaccine adjuvant.

The present invention further relates to immunogenic compositions comprising one or more outer membrane vesicles (OMVs) expressing or overexpressing one or more polypeptides encoded by:

(a) a nucleotide sequence selected from the group consisting of SEQ ID NOs 511, 2453, 2455, 2677, 2691, 4595, 4747, 7003, 7051, 8167, 4627 and 5699; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

The present invention also relates to immunogenic compositions comprising one or more OMVs expressing or overexpressing one or more polypeptides encoded by: (a) a nucleotide sequence selected from the group consisting of SEQ ID Nos 8563, 2727, 9871, 4671, 5679, 533, 3221, 3225 and 7003; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

The present invention also relates to methods for raising an immune response in a patient, comprising the step of administering to the patient a pharmaceutical composition or immunogenic composition of the invention. In a particular embodiment, the immune response is protective against ExPEC infection, and in particular against a MNEC infection.

Further aspects of the invention are described below.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the % survival of mice over time after challenge with IHE3034 following immunization with heat-inactivated IHE3034 or with a control ('fisiol'), and also bacteremia levels (cfu/ml) after 24 hours.

Figure 2 shows the % survival of mice after challenge with IHE3034 following immunization either with heat-inactivated bacteria (top) or with vesicles (bottom) from ΔTolR mutants. Immunogens were prepared from the IHE3034 strain or from a control strain (DH5).

Figure 3 shows the % survival of mice after challenge with IHE3034 following immunization with IroN or a control (top) and the serum anti-IroN Ig titer (bottom).

Figure 4 is similar to Figure 3, but for IbeA rather than IroN.

DETAILED DESCRIPTION OF THE INVENTION

The inventors have identified 4995 open reading frames from a K1/B2 MNEC strain, and have identified a subset of these that is of particular interest for preparing immunogenic compositions against MNEC strains.

Polypeptides

The invention provides polypeptides comprising the amino acid sequences disclosed in the examples. These amino acid sequences are given in the sequence listing as the even-numbered sequences SEQ ID NOs 2 to 9990.

Preferred amino acid sequences from within SEQ ID NOs 2 to 9990 are given in Table 2. Further preferred amino acid sequences are those not identified in the prior art *e.g.* not identified in any of references 5, 6, 7, 8, 9, 10, 11 and 13.

The invention also provides a polypeptide encoded within any one of nucleic acid sequences SEQ ID NOs 9991 to 10273 or within SEQ ID NO: 10274. The coding sequence in the nucleic acid preferably begins with a start codon and ends with a stop codon. Preferred polypeptides are those not identified in the prior art *e.g.* not identified in any of references 5, 6, 8, 10 and 11.

The invention also provides polypeptides comprising amino acid sequences that have sequence identity to the amino acid sequences disclosed in the examples. Similarly, the invention provides polypeptides comprising amino acid sequences that have sequence identity to the amino acid sequences encoded within SEQ ID NOs 9991 to 10273 or within SEQ ID NO: 10274. Depending on the particular sequence, the degree of sequence identity is preferably greater than 50% (*e.g.* 60%, 70%, 75%, 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99% or more). These polypeptides include homologs, orthologs, allelic variants and mutants. Typically, 50% identity or more between two polypeptide sequences is considered to be an indication of functional equivalence. Identity between polypeptides is preferably determined by the Smith-Waterman homology search

Published
algorithm as implemented in the MPSRCH program (Oxford Molecular), using an affine gap search with parameters *gap open penalty=12* and *gap extension penalty=1*.

These polypeptide may, compared to the sequences of the examples, include one or more (*e.g.* 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, *etc.*) conservative amino acid substitutions *i.e.* replacements of one amino acid with another which has a related side chain. Genetically-encoded amino acids are generally divided into four families: (1) acidic *i.e.* aspartate, glutamate; (2) basic *i.e.* lysine, arginine, histidine; (3) non-polar *i.e.* alanine, valine, leucine, isoleucine, proline, phenylalanine, methionine, tryptophan; and (4) uncharged polar *i.e.* glycine, asparagine, glutamine, cysteine, serine, threonine, tyrosine. Phenylalanine, tryptophan, and tyrosine are sometimes classified jointly as aromatic amino acids. In general, substitution of single amino acids within these families does not have a major effect on the biological activity. Moreover, the polypeptides may have one or more (*e.g.* 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, *etc.*) single amino acid deletions relative to a reference sequence. Furthermore, the polypeptides may include one or more (*e.g.* 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, *etc.*) insertions (*e.g.* each of 1, 2, 3, 4 or 5 amino acids) relative to a reference sequence.

Preferred polypeptides include polypeptides that are lipidated, that are located in the outer membrane, that are located in the inner membrane, or that are located in the periplasm. Particularly preferred polypeptides are those that fall into more than one of these categories *e.g.* lipidated polypeptides that are located in the outer membrane. Lipoproteins may have a N-terminal cysteine to which lipid is covalently attached, following post-translational processing of the signal peptide.

Polypeptides that may be lipidated include SEQ ID NOs: 620, 630, 660, 724, 946, 1196, 1304, 1510, 1530, 1548, 1600, 1700, 1958, 2030, 2396, 2610, 3040, 3364, 3414, 3422, 3554, 3678, 3824, 4072, 4116, 4178, 4240, 4374, 4412, 4462, 4576, 4664, 4856, 5178, 5286, 5362, 5662, 5682, 5984, 6018, 6132, 6256, 6286, 6532, 6714, 6754, 6764, 6790, 6938, 7144, 7442, 7674, 7872, 8278, 8498, 8564, 8782, 8784, 9276 and 9580. SEQ ID NOs 5662 (*ORF02831*) and 8564 (*ORF04282*) are preferred lipoproteins.

Preferred polypeptides are those listed in Table 2.

The invention further provides polypeptides comprising fragments of the amino acid sequences disclosed in the examples. Similarly, the invention provides polypeptides comprising fragments of the amino acid sequences encoded within SEQ ID NOs 9991 to 10273 or within SEQ ID NO: 10274. The fragments should comprise at least *n* consecutive amino acids from the sequences and, depending on the particular sequence, *n* is 7 or more (*e.g.* 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100 or more). The fragment may comprise at least one T-cell or, preferably, a B-cell epitope of the sequence. T- and B-cell epitopes can be identified empirically (*e.g.* using PEPSCAN [14,15] or similar methods), or they can be predicted (*e.g.* using the Jameson-Wolf antigenic index [16], matrix-based approaches [17], TEPITOPE [18], neural networks [19], OptiMer & EpiMer [20,21], ADEPT [22], Tsites [23], hydrophilicity [24], antigenic index [25] or the

CLAIMED AREA

methods disclosed in reference 26, *etc.*). Other preferred fragments are (a) the N-terminal signal peptides of the polypeptides of the invention, (b) the polypeptides, but without their N-terminal signal peptides, (c) the polypeptides, but without 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10 of their N-terminal amino acid residue(s).

Other preferred fragments are those that begin with an amino acid encoded by a potential start codon (ATG, GTG, TTG). Fragments starting at the methionine encoded by a start codon downstream of the indicated start codon are polypeptides of the invention.

Other preferred fragments are those that are common to a polypeptide of the invention and to a polypeptide identified in any of references 5, 6, 8, 10 and 11.

Polypeptides of the invention can be prepared in many ways *e.g.* by chemical synthesis (in whole or in part), by digesting longer polypeptides using proteases, by translation from RNA, by purification from cell culture (*e.g.* from recombinant expression), from the organism itself (*e.g.* after bacterial culture, or direct from patients), *etc.* A preferred method for production of peptides <40 amino acids long involves *in vitro* chemical synthesis [27,28]. Solid-phase peptide synthesis is particularly preferred, such as methods based on tBoc or Fmoc [29] chemistry. Enzymatic synthesis [30] may also be used in part or in full. As an alternative to chemical synthesis, biological synthesis may be used *e.g.* the polypeptides may be produced by translation. This may be carried out *in vitro* or *in vivo*. Biological methods are in general restricted to the production of polypeptides based on L-amino acids, but manipulation of translation machinery (*e.g.* of aminoacyl tRNA molecules) can be used to allow the introduction of D-amino acids (or of other non natural amino acids, such as iodotyrosine or methylphenylalanine, azidohomoalanine, etc.) [31]. Where D-amino acids are included, however, it is preferred to use chemical synthesis. Polypeptides of the invention may have covalent modifications at the C-terminus and/or N-terminus.

Polypeptides of the invention can take various forms (*e.g.* native, fusions, glycosylated, non-glycosylated, lipidated, non-lipidated, phosphorylated, non-phosphorylated, myristoylated, non-myristoylated, monomeric, multimeric, particulate, denatured, *etc.*).

Polypeptides of the invention are preferably provided in purified or substantially purified form *i.e.* substantially free from other polypeptides (*e.g.* free from naturally-occurring polypeptides), particularly from other ExPEC or host cell polypeptides, and are generally at least about 50% pure (by weight), and usually at least about 90% pure *i.e.* less than about 50%, and more preferably less than about 10% (*e.g.* 5% or less) of a composition is made up of other expressed polypeptides. Polypeptides of the invention are preferably ExPEC, and more preferably MNEC, polypeptides.

Polypeptides of the invention may be attached to a solid support. Polypeptides of the invention may comprise a detectable label (*e.g.* a radioactive or fluorescent label, or a biotin label).

RECTIFIED SHEET

The term "polypeptide" refers to amino acid polymers of any length. The polymer may be linear or branched, it may comprise modified amino acids, and it may be interrupted by non-amino acids. The terms also encompass an amino acid polymer that has been modified naturally or by intervention; for example, disulfide bond formation, glycosylation, lipidation, acetylation, phosphorylation, or any other manipulation or modification, such as conjugation with a labeling component. Also included within the definition are, for example, polypeptides containing one or more analogs of an amino acid (including, for example, unnatural amino acids, *etc.*), as well as other modifications known in the art. Polypeptides can occur as single chains or associated chains. Polypeptides of the invention can be naturally or non-naturally glycosylated (*i.e.* the polypeptide has a glycosylation pattern that differs from the glycosylation pattern found in the corresponding naturally occurring polypeptide).

Polypeptides of the invention may be at least 40 amino acids long (*e.g.* at least 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 350, 400, 450, 500 or more). Polypeptides of the invention may be shorter than 500 amino acids (*e.g.* no longer than 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 350, 400 or 450 amino acids).

The invention provides polypeptides comprising a sequence -X-Y- or -Y-X-, wherein: -X- is an amino acid sequence as defined above and -Y- is not a sequence as defined above *i.e.* the invention provides fusion proteins. Where the N-terminus codon of a polypeptide-coding sequence is not ATG then that codon will be translated as the standard amino acid for that codon rather than as a Met, which occurs when the codon is translated as a start codon.

The invention provides a process for producing polypeptides of the invention, comprising the step of culturing a host cell of to the invention under conditions which induce polypeptide expression.

The invention provides a process for producing a polypeptide of the invention, wherein the polypeptide is synthesised in part or in whole using chemical means.

The invention provides a composition comprising two or more (*e.g.* 2, 3, 4, 5, 6 or more) polypeptides of the invention. The different polypeptides may be selected such that they are involved in different bacterial metabolic and/or signalling pathways *e.g.* selection from 2, 3, 4, 5, 6 or more of the following categories: adhesins; autotransporter proteins; toxins; iron acquisitions proteins; and membrane-associated proteins, including in particular integral outer membrane proteins. Such combinations of antigens may target the immune response against different aspects of the bacterial life cycle, resulting in a more effective immune response.

The invention also provides a hybrid polypeptide represented by the formula NH_2-A-[-X-L-]$_n$-B-COOH, wherein X is a polypeptide of the invention as defined above, L is an optional linker amino acid sequence, A is an optional N-terminal amino acid sequence, B is an optional C-terminal amino acid sequence, and n is an integer greater than 1. The value of n is between 2 and x, and the value of x is typically 3, 4, 5, 6, 7, 8, 9 or 10. Preferably n is 2, 3 or 4; it is more preferably 2 or 3; most

CT/US06/05913
preferably, $n = 2$. For each n instances, -X- may be the same or different. For each n instances of [-X-L-], linker amino acid sequence -L- may be present or absent. For instance, when n=2 the hybrid may be NH_2-X_1-L_1-X_2-L_2-COOH, NH_2-X_1-X_2-COOH, NH_2-X_1-L_1-X_2-COOH, NH_2-X_1-X_2-L_2-COOH, *etc.* Linker amino acid sequence(s) -L- will typically be short (*e.g.* 20 or fewer amino acids *i.e.* 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1). Examples include short peptide sequences which facilitate cloning, poly-glycine linkers (*i.e.* Gly_n where n = 2, 3, 4, 5, 6, 7, 8, 9, 10 or more), and histidine tags (*i.e.* His_n where n = 3, 4, 5, 6, 7, 8, 9, 10 or more). Other suitable linker amino acid sequences will be apparent to those skilled in the art. -A- and -B- are optional sequences which will typically be short (*e.g.* 40 or fewer amino acids *i.e.* 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1). Examples include leader sequences to direct polypeptide trafficking, or short peptide sequences which facilitate cloning or purification (*e.g.* histidine tags *i.e.* His_n where n = 3, 4, 5, 6, 7, 8, 9, 10 or more). Other suitable N-terminal and C-terminal amino acid sequences will be apparent to those skilled in the art.

Various tests can be used to assess the *in vivo* immunogenicity of polypeptides of the invention. For example, polypeptides can be expressed recombinantly and used to screen patient sera by immunoblot. A positive reaction between the polypeptide and patient serum indicates that the patient has previously mounted an immune response to the protein in question *i.e.* the protein is an immunogen. This method can also be used to identify immunodominant proteins.

Antibodies

The invention provides antibodies that bind to polypeptides of the invention. These may be polyclonal or monoclonal and may be produced by any suitable means (*e.g.* by recombinant expression). To increase compatibility with the human immune system, the antibodies may be chimeric or humanised [*e.g.* refs. 32 & 33], or fully human antibodies may be used. The antibodies may include a detectable label (*e.g.* for diagnostic assays). Antibodies of the invention may be attached to a solid support. Antibodies of the invention are preferably neutralising antibodies.

Monoclonal antibodies are particularly useful in identification and purification of the individual polypeptides against which they are directed. Monoclonal antibodies of the invention may also be employed as reagents in immunoassays, radioimmunoassays (RIA) or enzyme-linked immunosorbent assays (ELISA), *etc.* In these applications, the antibodies can be labelled with an analytically-detectable reagent such as a radioisotope, a fluorescent molecule or an enzyme. The monoclonal antibodies produced by the above method may also be used for the molecular identification and characterization (epitope mapping) of polypeptides of the invention.

Antibodies of the invention are preferably specific to ExPEC strains of *E.coli, i.e.* they bind preferentially to ExPEC *E.coli* relative to other bacteria (*e.g.* relative to non-ExPEC *E.coli* and

relative to non-*E.coli* bacteria). More preferably, the antibodies are specific to MNEC strains *i.e.* they bind preferentially to MNEC bacteria relative to other bacteria, including relative to other ExPEC *E.coli*.

Antibodies of the invention are preferably provided in purified or substantially purified form. Typically, the antibody will be present in a composition that is substantially free of other polypeptides *e.g.* where less than 90% (by weight), usually less than 60% and more usually less than 50% of the composition is made up of other polypeptides.

Antibodies of the invention can be of any isotype (*e.g.* IgA, IgG, IgM *i.e.* an α, γ or μ heavy chain), but will generally be IgG. Within the IgG isotype, antibodies may be IgG1, IgG2, IgG3 or IgG4 subclass. Antibodies of the invention may have a κ or a λ light chain.

Antibodies of the invention can take various forms, including whole antibodies, antibody fragments such as $F(ab')_2$ and F(ab) fragments, Fv fragments (non-covalent heterodimers), single-chain antibodies such as single chain Fv molecules (scFv), minibodies, oligobodies, *etc.* The term "antibody" does not imply any particular origin, and includes antibodies obtained through non-conventional processes, such as phage display.

The invention provides a process for detecting polypeptides of the invention, comprising the steps of: (a) contacting an antibody of the invention with a biological sample under conditions suitable for the formation of an antibody-antigen complexes; and (b) detecting said complexes.

The invention provides a process for detecting antibodies of the invention, comprising the steps of: (a) contacting a polypeptide of the invention with a biological sample (*e.g.* a blood or serum sample) under conditions suitable for the formation of an antibody-antigen complexes; and (b) detecting said complexes.

Preferred antibodies bind to a polypeptide of the invention with substantially greater affinity than antibodies known in the art. Preferably, the affinity is at least 1.5-fold, 2-fold, 5-fold 10-fold, 100-fold, 10^3-fold, 10^4-fold, 10^5-fold, 10^6-fold *etc.* stronger than antibodies known in the art.

Nucleic acids

The invention also provides nucleic acid comprising a nucleotide sequence encoding the polypeptides of the invention (*e.g.* the odd-numbered SEQ ID NOs: 1 to 9989). The invention also provides nucleic acid comprising any one of SEQ ID NOs 9991 to 10273.

The invention also provides nucleic acid comprising nucleotide sequences having sequence identity to such nucleotide sequences. Identity between sequences is preferably determined by the Smith-Waterman homology search algorithm as described above. Depending on the particular sequence, the degree of sequence identity is preferably greater than 50% (*e.g.* 60%, 70%, 75%, 80%, 85%, 90%, 91%, 92%, 93%, 94%, 95%, 96%, 97%, 98%, 99% or more).

The invention also provides nucleic acid which can hybridize to these nucleic acids. Hybridization reactions can be performed under conditions of different "stringency". Conditions that increase stringency of a hybridization reaction of widely known and published in the art [*e.g.* page 7.52 of reference 34]. Examples of relevant conditions include (in order of increasing stringency): incubation temperatures of 25°C, 37°C, 50°C, 55°C and 68°C; buffer concentrations of 10 x SSC, 6 x SSC, 1 x SSC, 0.1 x SSC (where SSC is 0.15 M NaCl and 15 mM citrate buffer) and their equivalents using other buffer systems; formamide concentrations of 0%, 25%, 50%, and 75%; incubation times from 5 minutes to 24 hours; 1, 2, or more washing steps; wash incubation times of 1, 2, or 15 minutes; and wash solutions of 6 x SSC, 1 x SSC, 0.1 x SSC, or de-ionized water. Hybridization techniques and their optimization are well known in the art [*e.g.* see refs 34-37, *etc.*].

In some embodiments, nucleic acid of the invention hybridizes to a target under low stringency conditions; in other embodiments it hybridizes under intermediate stringency conditions; in preferred embodiments, it hybridizes under high stringency conditions. An exemplary set of low stringency hybridization conditions is 50°C and 10 x SSC. An exemplary set of intermediate stringency hybridization conditions is 55°C and 1 x SSC. An exemplary set of high stringency hybridization conditions is 68°C and 0.1 x SSC.

Nucleic acid comprising fragments of these sequences are also provided. These should comprise at least *n* consecutive nucleotides from the sequences and, depending on the particular sequence, *n* is 10 or more (*e.g.* 12, 14, 15, 18, 20, 25, 30, 35, 40, 50, 60, 70, 80, 90, 100, 150, 200 or more). Preferred fragments are those that are common to a nucleic acid sequence of the invention and to a nucleic acid sequence identified in any of references 5, 6, 8, 10 and 11.

The invention provides nucleic acid of formula 5'-X-Y-Z-3', wherein: -X- is a nucleotide sequence consisting of *x* nucleotides; -Z- is a nucleotide sequence consisting of *z* nucleotides; -Y- is a nucleotide sequence consisting of either (a) a fragment of a nucleic acid sequence selected from odd-numbered SEQ ID NOS: 1 to 9989, (b) a fragment of any one of SEQ ID NOs 9991 to 10273; (c) a fragment of SEQ ID NO: 10274; or (d) the complement of (a) or (b) or (c); and said nucleic acid 5'-X-Y-Z-3' is neither (i) a fragment of either an odd-numbered nucleic acid from SEQ ID NOS: 1 to 9989 or of SEQ ID NOs 9991 to 10273 or of SEQ ID NO: 10274, nor (ii) the complement of (i). The -X- and/or -Z- moieties may comprise a promoter sequence (or its complement).

The invention also provides nucleic acid comprising a fragment of at least *n* consecutive nucleotides from SEQ ID 10274, wherein *n* is 10 or more *e.g.* 12, 14, 15, 18, 20, 25, 30, 35, 40, 50, 60, 70, 80, 90, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 800, 900, 1000, 1500, 2000, 3000, 4000, 5000, 10000, 100000, 1000000 or more. This nucleic acid may be single-stranded, at least in part, such that it can act as a hybridisation probe and/or amplification primer. In some embodiments, the fragment is not, or does not include, a fragment of a prior art ExPEC sequence *e.g.* not a fragment of a nucleic acid sequence specifically disclosed in any of refs. 5, 6, 7, 8, 9, 10, 11 and 13. In other

embodiments, the fragment is also a fragment of a prior art ExPEC sequence *e.g.* is identical to a fragment of a nucleic acid sequence specifically disclosed in any of refs. 5, 6, 7, 8, 9, 10, 11 and 13.

The invention includes nucleic acid comprising sequences complementary to these sequences (*e.g.* for antisense or probing, or for use as primers).

Nucleic acids of the invention can be used in hybridisation reactions (*e.g.* Northern or Southern blots, or in nucleic acid microarrays or 'gene chips') and amplification reactions (*e.g.* PCR, SDA, SSSR, LCR, TMA, NASBA, *etc.*) and other nucleic acid techniques.

Nucleic acid according to the invention can take various forms (*e.g.* single-stranded, double-stranded, vectors, primers, probes, labelled *etc.*). Nucleic acids of the invention may be circular or branched, but will generally be linear. Unless otherwise specified or required, any embodiment of the invention that utilizes a nucleic acid may utilize both the double-stranded form and each of two complementary single-stranded forms which make up the double-stranded form. Primers and probes are generally single-stranded, as are antisense nucleic acids.

Nucleic acids of the invention are preferably provided in purified or substantially purified form *i.e.* substantially free from other nucleic acids (*e.g.* free from naturally-occurring nucleic acids), particularly from other ExPEC or host cell nucleic acids, generally being at least about 50% pure (by weight), and usually at least about 90% pure. Nucleic acids of the invention are preferably ExPEC nucleic acids.

Nucleic acids of the invention may be prepared in many ways *e.g.* by chemical synthesis (*e.g.* phosphoramidite synthesis of DNA) in whole or in part, by digesting longer nucleic acids using nucleases (*e.g.* restriction enzymes), by joining shorter nucleic acids or nucleotides (*e.g.* using ligases or polymerases), from genomic or cDNA libraries, *etc.*

Nucleic acid of the invention may be attached to a solid support (*e.g.* a bead, plate, filter, film, slide, microarray support, resin, *etc.*). Nucleic acid of the invention may be labelled *e.g.* with a radioactive or fluorescent label, or a biotin label. This is particularly useful where the nucleic acid is to be used in detection techniques *e.g.* where the nucleic acid is a primer or as a probe.

The term "nucleic acid" includes in general means a polymeric form of nucleotides of any length, which contain deoxyribonucleotides, ribonucleotides, and/or their analogs. It includes DNA, RNA, DNA/RNA hybrids. It also includes DNA or RNA analogs, such as those containing modified backbones (*e.g.* peptide nucleic acids (PNAs) or phosphorothioates) or modified bases. Thus the invention includes mRNA, tRNA, rRNA, ribozymes, DNA, cDNA, recombinant nucleic acids, branched nucleic acids, plasmids, vectors, probes, primers, *etc.*. Where nucleic acid of the invention takes the form of RNA, it may or may not have a 5' cap.

Nucleic acids of the invention comprise sequences, but they may also comprise non-ExPEC sequences (*e.g.* in nucleic acids of formula 5'-X-Y-Z-3', as defined above). This is particularly useful for primers, which may thus comprise a first sequence complementary to a nucleic acid target and a second sequence which is not complementary to the nucleic acid target. Any such non-complementary sequences in the primer are preferably 5' to the complementary sequences. Typical non-complementary sequences comprise restriction sites or promoter sequences.

Nucleic acids of the invention can be prepared in many ways *e.g.* by chemical synthesis (at least in part), by digesting longer nucleic acids using nucleases (*e.g.* restriction enzymes), by joining shorter nucleic acids (*e.g.* using ligases or polymerases), from genomic or cDNA libraries, *etc.*

Nucleic acids of the invention may be part of a vector *i.e.* part of a nucleic acid construct designed for transduction/transfection of one or more cell types. Vectors may be, for example, "cloning vectors" which are designed for isolation, propagation and replication of inserted nucleotides, "expression vectors" which are designed for expression of a nucleotide sequence in a host cell, "viral vectors" which is designed to result in the production of a recombinant virus or virus-like particle, or "shuttle vectors", which comprise the attributes of more than one type of vector. Preferred vectors are plasmids. A "host cell" includes an individual cell or cell culture which can be or has been a recipient of exogenous nucleic acid. Host cells include progeny of a single host cell, and the progeny may not necessarily be completely identical (in morphology or in total DNA complement) to the original parent cell due to natural, accidental, or deliberate mutation and/or change. Host cells include cells transfected or infected *in vivo* or *in vitro* with nucleic acid of the invention.

Where a nucleic acid is DNA, it will be appreciated that "U" in a RNA sequence will be replaced by "T" in the DNA. Similarly, where a nucleic acid is RNA, it will be appreciated that "T" in a DNA sequence will be replaced by "U" in the RNA.

The term "complement" or "complementary" when used in relation to nucleic acids refers to Watson-Crick base pairing. Thus the complement of C is G, the complement of G is C, the complement of A is T (or U), and the complement of T (or U) is A. It is also possible to use bases such as I (the purine inosine) *e.g.* to complement pyrimidines (C or T). The terms also imply a direction – the complement of 5'-ACAGT-3' is 5'-ACTGT-3' rather than 5'-TGTCA-3'.

Nucleic acids of the invention can be used, for example: to produce polypeptides; as hybridization probes for the detection of nucleic acid in biological samples; to generate additional copies of the nucleic acids; to generate ribozymes or antisense oligonucleotides; as single-stranded DNA primers or probes; or as triple-strand forming oligonucleotides.

The invention provides a process for producing nucleic acid of the invention, wherein the nucleic acid is synthesised in part or in whole using chemical means.

The invention provides vectors comprising nucleotide sequences of the invention (*e.g.* cloning or expression vectors) and host cells transformed with such vectors.

The invention also provides a kit comprising primers (*e.g.* PCR primers) for amplifying a template sequence contained within an ExPEC nucleic acid sequence, the kit comprising a first primer and a second primer, wherein the first primer is substantially complementary to said template sequence and the second primer is substantially complementary to a complement of said template sequence, wherein the parts of said primers which have substantial complementarity define the termini of the template sequence to be amplified. The first primer and/or the second primer may include a detectable label (*e.g.* a fluorescent label).

The invention also provides a kit comprising first and second single-stranded oligonucleotides which allow amplification of a ExPEC template nucleic acid sequence contained in a single- or double-stranded nucleic acid (or mixture thereof), wherein: (a) the first oligonucleotide comprises a primer sequence which is substantially complementary to said template nucleic acid sequence; (b) the second oligonucleotide comprises a primer sequence which is substantially complementary to the complement of said template nucleic acid sequence; (c) the first oligonucleotide and/or the second oligonucleotide comprise(s) sequence which is not complementary to said template nucleic acid; and (d) said primer sequences define the termini of the template sequence to be amplified. The non-complementary sequence(s) of feature (c) are preferably upstream of (*i.e.* 5' to) the primer sequences. One or both of these (c) sequences may comprise a restriction site [*e.g.* ref. 38] or a promoter sequence [*e.g.* 39]. The first oligonucleotide and/or the second oligonucleotide may include a detectable label (*e.g.* a fluorescent label).

The template sequence may be any part of a genome sequence (*e.g.* SEQ ID NO:10274). For example, it could be a rRNA gene (*e.g.* Turenne *et al.* (2000) *J. Clin. Microbiol.* 38:513-520) or a protein-coding gene. The template sequence is preferably specific to ExPEC, and more preferably to MNEC.

The invention also provides a computer-readable medium (*e.g.* a floppy disk, a hard disk, a CD-ROM, a DVD *etc.*) and/or a computer database containing one or more of the sequences in the sequence listing. The medium preferably contains SEQ ID NO: 10274.

The invention provides a process for detecting nucleic acid of the invention, comprising the steps of: (a) contacting a nucleic probe according to the invention with a biological sample under hybridising conditions to form duplexes; and (b) detecting said duplexes.

The invention provides a process for detecting in a biological sample (*e.g.* blood), comprising the step of contacting nucleic acid according to the invention with the biological sample under hybridising conditions. The process may involve nucleic acid amplification (*e.g.* PCR, SDA, SSSR, LCR, TMA, NASBA, *etc.*) or hybridisation (*e.g.* microarrays, blots, hybridisation with a probe in

solution *etc.*). PCR detection of ExPEC in clinical samples has been reported [*e.g.* see ref. 40]. Clinical assays based on nucleic acid are described in general in ref. 41.

The invention provides a process for preparing a fragment of a target sequence, wherein the fragment is prepared by extension of a nucleic acid primer. The target sequence and/or the primer are nucleic acids of the invention. The primer extension reaction may involve nucleic acid amplification (*e.g.* PCR, SDA, SSSR, LCR, TMA, NASBA, *etc.*).

Nucleic acid amplification according to the invention may be quantitative and/or real-time.

For certain embodiments of the invention, nucleic acids are preferably at least 7 nucleotides in length (*e.g.* 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 45, 50, 55, 60, 65, 70, 75, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 225, 250, 275, 300 nucleotides or longer).

For certain embodiments of the invention, nucleic acids are preferably at most 500 nucleotides in length (*e.g.* 450, 400, 350, 300, 250, 200, 150, 140, 130, 120, 110, 100, 90, 80, 75, 70, 65, 60, 55, 50, 45, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15 nucleotides or shorter).

Primers and probes of the invention, and other nucleic acids used for hybridization, are preferably between 10 and 30 nucleotides in length (*e.g.* 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30 nucleotides).

Mutant bacteria

The invention provides a *E.coli* bacterium in which expression of one or more of the genes identified herein has been knocked out. Techniques for gene knockout are well known, and knockout mutants of *E.coli* have been reported previously.

The knockout is preferably achieved using isogenic deletion of the coding region, but any other suitable technique may be used *e.g.* deletion or mutation of the promoter, deletion or mutation of the start codon, antisense inhibition, inhibitory RNA, *etc.* In the resulting bacterium, however, mRNA encoding the gene product will be absent and/or its translation will be inhibited (*e.g.* to less than 1% of wild-type levels).

The bacterium may contain a marker gene in place of the knocked out gene *e.g.* an antibiotic resistance marker.

Vesicles

Reference 42 describes the preparation of vesicles from a MNEC strain by the knockout of *mltA* (a murein lytic transglycosylase) or one or more of the components of the *E.coli* Tol-Pal complex [43], such as *tolA, tolQ, tolB, pal* and/or *tolR*. These vesicles can be improved by making one or more

further genetic changes to the chromosome of the bacterium or through insertion of "ad-hoc" episomalic elements (*e.g.* expression vectors) in order to increase the amount of and/or immunoaccessibility "exposure" of protective antigens on the surface the vesicles.

One way of obtaining such improvements is to up-regulate the expression of the polypeptides protective antigens of the invention. Many different genetic strategies for increasing the expression of a target protein are well-known in the art and can be distinguished into two broad categories: one relying on modifications of the chromosome (*e.g.* replacement of the wild-type promoter with a stronger promoter, inactivation of natural repressor genes, *etc.*) to increase expression of an endogenous gene, and the other based on recombinant expression by episomalic elements (*e.g.* high-copy number plasmids, vectors harboring an engineered target gene, *etc.*) or integration of a exogenous protective target gene in the chromosome. Practical examples for each of these approaches can be found in references 44 to 50.

Another way of increasing vesicle immunogenicity and selectivity is to down-regulate the expression of immunodominant non-protective antigens or to down-regulate proteins that are homologous to proteins found in commensal strains. Further improvements can be achieved sought by reducing the potential vesicle toxicity through detoxification of the Lipid A moiety of LPS. Similar changes have been previously described to produce improved vesicles from other Gram-negative pathogens (see for example references 51 & 52).

All the above strategies can be used either alone or in combination to obtain improved vesicles for use in immunogenic compositions. The invention provides a pathogenic *Escherichia coli* bacterium (particularly a MNEC) having a knockout of *mltA* and/or of a component of its *Tol-Pal* complex, and one or more of: (i) a chromosomal gene encoding a polypeptide of the invention under the control of a promoter that provides higher expression levels of the polypeptide than the promoter that is naturally associated with the gene encoding the polypeptide; (ii) an autonomously-replicating extrachromosomal element encoding a polypeptide of the invention; and/or (iii) a genetic modification to reduce the toxicity of the Lipid A moiety of *E.coli* LPS relative to wild-type LPS.

The invention also provides vesicles obtainable by culturing such a bacterium, such as the vesicles that, during culture of the bacterium, are released into the culture medium.

Pharmaceutical compositions

The invention provides compositions comprising: (a) polypeptide, antibody, vesicles, and/or nucleic acid of the invention; and (b) a pharmaceutically acceptable carrier. These compositions may be suitable as immunogenic compositions, for instance, or as diagnostic reagents, or as vaccines. Vaccines according to the invention may either be prophylactic (*i.e.* to prevent infection) or therapeutic (*i.e.* to treat infection), but will typically be prophylactic.

PCT/US2006/005913

In a particular aspect, the invention provides immunogenic compositions comprising one or more outer membrane vesicles (OMVs) expressing or overexpressing one or more polypeptides encoded by: (a) a nucleotide sequence selected from the group consisting of SEQ ID NOs 511, 2453, 2455, 2677, 2691, 4595, 4747, 7003, 7051, 8167, 4627 and 5699; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

In another aspect, the invention provides immunogenic compositions comprising one or more outer membrane vesicles (OMVs) expressing or overexpressing one or more polypeptides encoded by: (a) a nucleotide sequence selected from the group consisting of SEQ ID Nos 8563, 2727, 9871, 4671, 5679, 533, 3221, 3225 and 7003; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

A 'pharmaceutically acceptable carrier' includes any carrier that does not itself induce the production of antibodies harmful to the individual receiving the composition. Suitable carriers are typically large, slowly metabolised macromolecules such as proteins, polysaccharides, polylactic acids, polyglycolic acids, polymeric amino acids, amino acid copolymers, sucrose, trehalose, lactose, and lipid aggregates (such as oil droplets or liposomes). Such carriers are well known to those of ordinary skill in the art. The vaccines may also contain diluents, such as water, saline, glycerol, *etc.* Additionally, auxiliary substances, such as wetting or emulsifying agents, pH buffering substances, and the like, may be present. Sterile pyrogen-free, phosphate-buffered physiologic saline is a typical carrier. A thorough discussion of pharmaceutically acceptable excipients is available in ref. 289.

Compositions of the invention may include an antimicrobial, particularly if packaged in a multiple dose format.

Compositions of the invention may comprise detergent *e.g.* a Tween (polysorbate), such as Tween 80. Detergents are generally present at low levels *e.g.* <0.01%.

Compositions of the invention may include sodium salts (*e.g.* sodium chloride) to give tonicity. A concentration of 10±2mg/ml NaCl is typical.

Compositions of the invention will generally include a buffer. A phosphate buffer is typical.

Compositions of the invention may comprise a sugar alcohol (*e.g.* mannitol) or a disaccharide (*e.g.* sucrose or trehalose) *e.g.* at around 15-30mg/ml (*e.g.* 25 mg/ml), particularly if they are to be

lyophilised or if they include material which has been reconstituted from lyophilised material. The pH of a composition for lyophilisation may be adjusted to around 6.1 prior to lyophilisation.

Polypeptides of the invention may be administered in conjunction with other immunoregulatory agents. In particular, compositions will usually include a vaccine adjuvant. The adjuvant may be selected from one or more of the group consisting of a TH1 adjuvant and TH2 adjuvant, further discussed below. Adjuvants which may be used in compositions of the invention include, but are not limited to:

A. Mineral-containing compositions

Mineral containing compositions suitable for use as adjuvants in the invention include mineral salts, such as aluminium salts and calcium salts. The invention includes mineral salts such as hydroxides (*e.g.* oxyhydroxides), phosphates (*e.g.* hydroxyphosphates, orthophosphates), sulphates, *etc.* [*e.g.* see chapters 8 & 9 of ref. 53], or mixtures of different mineral compounds (*e.g.* a mixture of a phosphate and a hydroxide adjuvant, optionally with an excess of the phosphate), with the compounds taking any suitable form (*e.g.* gel, crystalline, amorphous, *etc.*), and with adsorption to the salt(s) being preferred. Mineral containing compositions may also be formulated as a particle of metal salt [54].

Aluminum salts may be included in vaccines of the invention such that the dose of Al^{3+} is between 0.2 and 1.0 mg per dose.

In another embodiment the adjuvant of the invention comprises both aluminum phosphate and aluminum hydroxide. In a more particular embodiment thereof, the adjuvant has a greater amount of aluminum phosphate than aluminum hydroxide, such as a ratio of 2:1, 3:1, 4:1, 5:1, 6:1, 7:1, 8:1, 9:1 or greater than 9:1, by weight aluminum phosphate to aluminum hydroxide. More particular still, aluminum salts in the vaccine are present at 0.4 to 1.0 mg per vaccine dose, or 0.4 to 0.8 mg per vaccine dose, or 0.5 to 0.7 mg per vaccine dose, or about 0.6 mg per vaccine dose.

Generally, the preferred aluminum-based adjuvant(s), or ratio of multiple aluminum-based adjuvants, such as aluminum phosphate to aluminum hydroxide is selected by optimization of electrostatic attraction between molecules such that the antigen carries an opposite charge as the adjuvant at the desired pH. For example, an aluminum phosphate adjuvant with pI ~4 electrostatically adsorbs lysozyme, but not albumin, at pH 7.4. Should albumin be the target, aluminum hydroxide adjuvant would be selected (*e.g.* with pH 11.4). Alternatively, pre-treatment of aluminum hydroxide with phosphate lowers its pI, making it a preferred adjuvant for more basic antigens.

A typical aluminium phosphate adjuvant is amorphous aluminium hydroxyphosphate with PO_4/Al molar ratio between 0.84 and 0.92, included at 0.6mg Al^{3+}/ml. Adsorption with a low dose of aluminium phosphate may be used *e.g.* between 50 and 100μg Al^{3+} per conjugate per dose. Where an

aluminium phosphate it used and it is desired not to adsorb an antigen to the adjuvant, this is favoured by including free phosphate ions in solution (*e.g.* by the use of a phosphate buffer).

B. Oil Emulsions

Oil emulsion compositions suitable for use as adjuvants in the invention include squalene-water emulsions, such as MF59 (5% Squalene, 0.5% Tween 80, and 0.5% Span 85, formulated into submicron particles using a microfluidizer) [Chapter 10 of ref. 53; see also refs. 55-57chapter 12 of ref. 58.]. MF59 is used as the adjuvant in the FLUAD™ influenza virus trivalent subunit vaccine. The emulsion advantageously includes citrate ions e.g. 10mM sodium citrate buffer.

Particularly preferred adjuvants for use in the compositions are submicron oil-in-water emulsions. Preferred submicron oil-in-water emulsions for use herein are squalene/water emulsions, optionally containing varying amounts of MTP-PE, such as a submicron oil-in-water emulsion containing 4-5% w/v squalene, 0.25-1.0% w/v Tween 80 (polyoxyelthylenesorbitan monooleate), and/or 0.25-1.0% Span 85 (sorbitan trioleate), and, optionally, N-acetylmuramyl-L-alanyl-D-isogluatminyl-L-alanine-2-(1'-2'-dipalmitoyl-sn-glycero-3-hydroxyphosphophoryloxy)-ethylamine (MTP-PE). Submicron oil-in-water emulsions, methods of making the same and immunostimulating agents, such as muramyl peptides, for use in the compositions, are described in detail in references 55 & 59-60.

An emulsion of squalene, a tocopherol, and Tween 80 can be used. The emulsion may include phosphate buffered saline. It may also include Span 85 (*e.g.* at 1%) and/or lecithin. These emulsions may have from 2 to 10% squalene, from 2 to 10% tocopherol and from 0.3 to 3% Tween 80, and the weight ratio of squalene:tocopherol is preferably ≤ 1 as this provides a more stable emulsion. One such emulsion can be made by dissolving Tween 80 in PBS to give a 2% solution, then mixing 90ml of this solution with a mixture of (5g of DL-α-tocopherol and 5ml squalene), then microfluidising the mixture. The resulting emulsion may have submicron oil droplets *e.g.* with an average diameter of between 100 and 250nm, preferably about 180nm.

An emulsion of squalene, a tocopherol, and a Triton detergent (*e.g.* Triton X-100) can be used.

An emulsion of squalane, polysorbate 80 and poloxamer 401 ("Pluronic™ L121") can be used. The emulsion can be formulated in phosphate buffered saline, pH 7.4. This emulsion is a useful delivery vehicle for muramyl dipeptides, and has been used with threonyl-MDP in the "SAF-1" adjuvant [61] (0.05-1% Thr-MDP, 5% squalane, 2.5% Pluronic L121 and 0.2% polysorbate 80). It can also be used without the Thr-MDP, as in the "AF" adjuvant [62] (5% squalane, 1.25% Pluronic L121 and 0.2% polysorbate 80). Microfluidisation is preferred.

Complete Freund's adjuvant (CFA) and incomplete Freund's adjuvant (IFA) may also be used as adjuvants in the invention.

C. Saponin formulations [chapter 22 of ref. 53]

Saponin formulations may also be used as adjuvants in the invention. Saponins are a heterologous group of sterol glycosides and triterpenoid glycosides that are found in the bark, leaves, stems, roots and even flowers of a wide range of plant species. Saponins isolated from the bark of the *Quillaia saponaria* Molina tree have been widely studied as adjuvants. Saponin can also be commercially obtained from *Smilax ornata* (sarsaprilla), *Gypsophilla paniculata* (brides veil), and *Saponaria officianalis* (soap root). Saponin adjuvant formulations include purified formulations, such as QS21, as well as lipid formulations, such as ISCOMs.

Saponin compositions have been purified using HPLC and RP-HPLC. Specific purified fractions using these techniques have been identified, including QS7, QS17, QS18, QS21, QH-A, QH-B and QH-C. Preferably, the saponin is QS21. A method of production of QS21 is disclosed in ref. 63. Saponin formulations may also comprise a sterol, such as cholesterol [64].

Combinations of saponins and cholesterols can be used to form unique particles called immunostimulating complexs (ISCOMs) [chapter 23 of ref. 53]. ISCOMs typically also include a phospholipid such as phosphatidylethanolamine or phosphatidylcholine. Any known saponin can be used in ISCOMs. Preferably, the ISCOM includes one or more of QuilA, QHA and QHC. ISCOMs are further described in refs. 64-66. Optionally, the ISCOMS may be devoid of additional detergent(s) [67].

A review of the development of saponin based adjuvants can be found in refs. 68 & 69.

D. Virosomes and virus-like particles

Virosomes and virus-like particles (VLPs) can also be used as adjuvants in the invention. These structures generally contain one or more proteins from a virus optionally combined or formulated with a phospholipid. They are generally non-pathogenic, non-replicating and generally do not contain any of the native viral genome. The viral proteins may be recombinantly produced or isolated from whole viruses. These viral proteins suitable for use in virosomes or VLPs include proteins derived from influenza virus (such as HA or NA), Hepatitis B virus (such as core or capsid proteins), Hepatitis E virus, measles virus, Sindbis virus, Rotavirus, Foot-and-Mouth Disease virus, Retrovirus, Norwalk virus, human Papilloma virus, HIV, RNA-phages, Qß-phage (such as coat proteins), GA-phage, fr-phage, AP205 phage, and Ty (such as retrotransposon Ty protein p1). VLPs are discussed further in refs. 70-75. Virosomes are discussed further in, for example, ref. 76

E. Bacterial or microbial derivatives

Adjuvants suitable for use in the invention include bacterial or microbial derivatives such as non-toxic derivatives of enterobacterial lipopolysaccharide (LPS), Lipid A derivatives, immunostimulatory oligonucleotides and ADP-ribosylating toxins and detoxified derivatives thereof.

Non-toxic derivatives of LPS include monophosphoryl lipid A (MPL) and 3-O-deacylated MPL (3dMPL). 3dMPL is a mixture of 3 de-O-acylated monophosphoryl lipid A with 4, 5 or 6 acylated chains. A preferred "small particle" form of 3 De-O-acylated monophosphoryl lipid A is disclosed in ref. 77. Such "small particles" of 3dMPL are small enough to be sterile filtered through a 0.22μm membrane [77]. Other non-toxic LPS derivatives include monophosphoryl lipid A mimics, such as aminoalkyl glucosaminide phosphate derivatives *e.g.* RC-529 [78,79].

Lipid A derivatives include derivatives of lipid A from *Escherichia coli* such as OM-174. OM-174 is described for example in refs. 80 & 81.

Immunostimulatory oligonucleotides suitable for use as adjuvants in the invention include nucleotide sequences containing a CpG motif (a dinucleotide sequence containing an unmethylated cytosine linked by a phosphate bond to a guanosine). Double-stranded RNAs and oligonucleotides containing palindromic or poly(dG) sequences have also been shown to be immunostimulatory.

The CpG's can include nucleotide modifications/analogs such as phosphorothioate modifications and can be double-stranded or single-stranded. References 82, 83 and 84 disclose possible analog substitutions *e.g.* replacement of guanosine with 2'-deoxy-7-deazaguanosine. The adjuvant effect of CpG oligonucleotides is further discussed in refs. 85-90.

The CpG sequence may be directed to TLR9, such as the motif GTCGTT or TTCGTT [91]. The CpG sequence may be specific for inducing a Th1 immune response, such as a CpG-A ODN, or it may be more specific for inducing a B cell response, such a CpG-B ODN. CpG-A and CpG-B ODNs are discussed in refs. 92-94. Preferably, the CpG is a CpG-A ODN.

Preferably, the CpG oligonucleotide is constructed so that the 5' end is accessible for receptor recognition. Optionally, two CpG oligonucleotide sequences may be attached at their 3' ends to form "immunomers". See, for example, refs. 91 & 95-97.

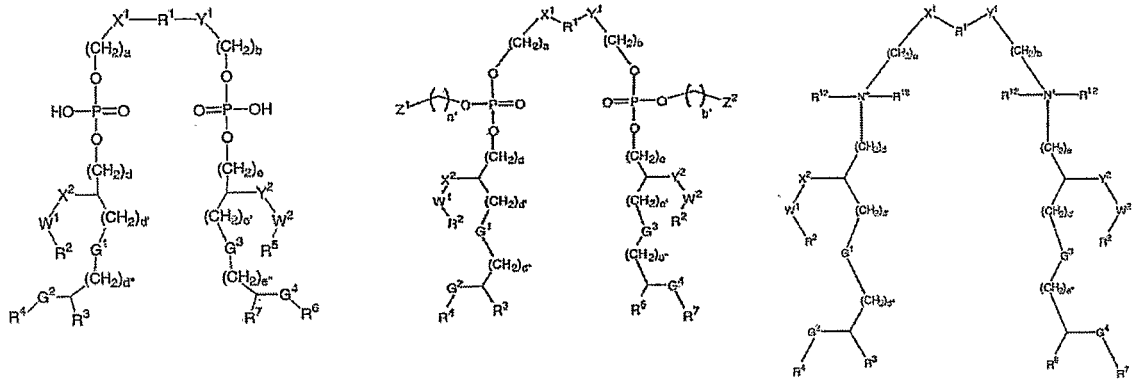
Other immunostimulatory oligonucleotides include a double-stranded RNA, or an oligonucleotide containing a palindromic sequence, or an oligonucleotide containing a poly(dG) sequence.

Bacterial ADP-ribosylating toxins and detoxified derivatives thereof may be used as adjuvants in the invention. Preferably, the protein is derived from *E.coli* (*E.coli* heat labile enterotoxin "LT"), cholera ("CT"), or pertussis ("PT"). The use of detoxified ADP-ribosylating toxins as mucosal adjuvants is described in ref. 98 and as parenteral adjuvants in ref. 99. The toxin or toxoid is preferably in the form of a holotoxin, comprising both A and B subunits. Preferably, the A subunit contains a detoxifying mutation; preferably the B subunit is not mutated. Preferably, the adjuvant is a detoxified LT mutant such as LT-K63, LT-R72, and LT-G192. The use of ADP-ribosylating toxins and detoxified derivaties thereof, particularly LT-K63 and LT-R72, as adjuvants can be found in refs. 100-107. Numerical reference for amino acid substitutions is preferably based on the alignments of

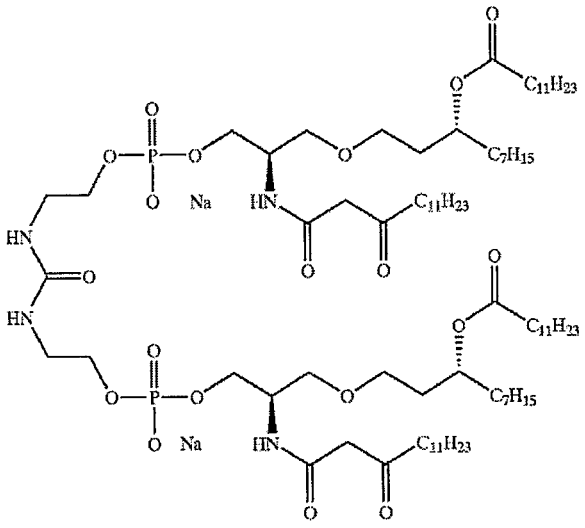
the A and B subunits of ADP-ribosylating toxins set forth in ref. 108, specifically incorporated herein by reference in its entirety.

Compounds of formula I, II or III, or salts thereof, can also be used as adjuvants:

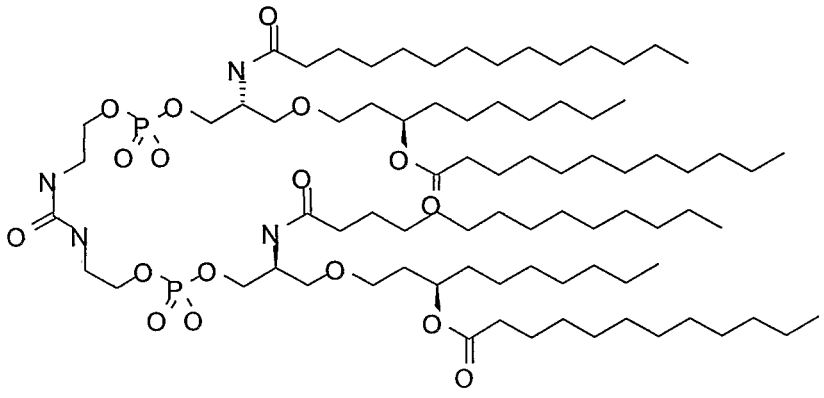
I II III



as defined in reference 109, such as 'ER 803058', 'ER 803732', 'ER 804053', ER 804058', 'ER 804059', 'ER 804442', 'ER 804680', 'ER 804764', ER 803022 or 'ER 804057' *e.g.*:



ER804057



ER-803022:

F. Human immunomodulators

Human immunomodulators suitable for use as adjuvants in the invention include cytokines, such as interleukins (*e.g.* IL-1, IL-2, IL-4, IL-5, IL-6, IL-7, IL-12 [110], *etc.*) [111], interferons (*e.g.* interferon-γ), macrophage colony stimulating factor, tumor necrosis factor and macrophage inflammatory protein-1alpha (MIP-1alpha) and MIP-1beta [112].

G. Bioadhesives and Mucoadhesives

Bioadhesives and mucoadhesives may also be used as adjuvants in the invention. Suitable bioadhesives include esterified hyaluronic acid microspheres [113] or mucoadhesives such as cross-linked derivatives of poly(acrylic acid), polyvinyl alcohol, polyvinyl pyrollidone, polysaccharides and carboxymethylcellulose. Chitosan and derivatives thereof may also be used as adjuvants in the invention [114].

H. Microparticles

Microparticles may also be used as adjuvants in the invention. Microparticles (*i.e.* a particle of ~100nm to ~150μm in diameter, more preferably ~200nm to ~30μm in diameter, and most preferably ~500nm to ~10μm in diameter) formed from materials that are biodegradable and non-toxic (*e.g.* a poly(α-hydroxy acid), a polyhydroxybutyric acid, a polyorthoester, a polyanhydride, a polycaprolactone, *etc.*), with poly(lactide-co-glycolide) are preferred, optionally treated to have a negatively-charged surface (*e.g.* with SDS) or a positively-charged surface (*e.g.* with a cationic detergent, such as CTAB).

I. Liposomes (Chapters 13 & 14 of ref. 53)

Examples of liposome formulations suitable for use as adjuvants are described in refs. 115-117.

J. Polyoxyethylene ether and polyoxyethylene ester formulations

Adjuvants suitable for use in the invention include polyoxyethylene ethers and polyoxyethylene esters [118]. Such formulations further include polyoxyethylene sorbitan ester surfactants in combination with an octoxynol [119] as well as polyoxyethylene alkyl ethers or ester surfactants in combination with at least one additional non-ionic surfactant such as an octoxynol [120]. Preferred polyoxyethylene ethers are selected from the following group: polyoxyethylene-9-lauryl ether (laureth 9), polyoxyethylene-9-steoryl ether, polyoxytheylene-8-steoryl ether, polyoxyethylene-4-lauryl ether, polyoxyethylene-35-lauryl ether, and polyoxyethylene-23-lauryl ether.

K. Phosphazenes e.g. *PCPP*

Phosphazene adjuvants include poly[di(carboxylatophenoxy)phosphazene] ("PCPP") as described, for example, in refs. 121 and 122.

L. Muramyl peptides

Examples of muramyl peptides suitable for use as adjuvants in the invention include N-acetyl-muramyl-L-threonyl-D-isoglutamine (thr-MDP), N-acetyl-normuramyl-L-alanyl-D-isoglutamine (nor-MDP), and N-acetylmuramyl-L-alanyl-D-isoglutaminyl-L-alanine-2-(1'-2'-dipalmitoyl-*sn*-glycero-3-hydroxyphosphoryloxy)-ethylamine MTP-PE).

M. Imidazoquinoline Compounds.

Imidazoquinoline adjuvants include Imiquimod ("R-837") [123,124], Resiquimod ("R-848") [125], and their analogs; and salts thereof (*e.g.* the hydrochloride salts). Further details about immunostimulatory imidazoquinolines can be found in references 126 to 130.

N. Thiosemicarbazone Compounds.

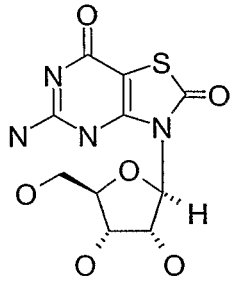
Examples of thiosemicarbazone compounds, as well as methods of formulating, manufacturing, and screening for compounds all suitable for use as adjuvants in the invention include those described in ref. 131. The thiosemicarbazones are particularly effective in the stimulation of human peripheral blood mononuclear cells for the production of cytokines, such as TNF-α.

O. Tryptanthrin Compounds.

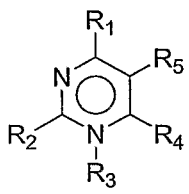
Examples of tryptanthrin compounds, as well as methods of formulating, manufacturing, and screening for compounds all suitable for use as adjuvants in the invention include those described in ref. 132. The tryptanthrin compounds are particularly effective in the stimulation of human peripheral blood mononuclear cells for the production of cytokines, such as TNF-α.

P. Nucleoside analogs

Various nucleoside analogs can be used as adjuvants, such as (a) Isatorabine (ANA-245; 7-thia-8-oxoguanosine):



and prodrugs thereof; (b) ANA975; (c) ANA-025-1; (d) ANA380; (e) the compounds disclosed in references 133 to 135; (f) a compound having the formula:



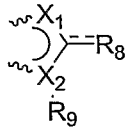
ST/US06/05913

wherein

R_1 and R_2 are each independently H, halo, $-NR_aR_b$, -OH, C_{1-6} alkoxy, substituted C_{1-6} alkoxy, heterocyclyl, substituted heterocyclyl, C_{6-10} aryl, substituted C_{6-10} aryl, C_{1-6} alkyl, or substituted C_{1-6} alkyl;

R_3 is absent, H, C_{1-6} alkyl, substituted C_{1-6} alkyl, C_{6-10} aryl, substituted C_{6-10} aryl, heterocyclyl, or substituted heterocyclyl;

R_4 and R_5 are each independently H, halo, heterocyclyl, substituted heterocyclyl, $-C(O)-R_d$, C_{1-6} alkyl, substituted C_{1-6} alkyl, or bound together to form a 5 membered ring as in R_{4-5}:



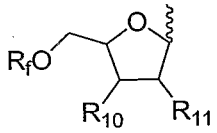
R_{4-5}

the binding being achieved at the bonds indicated by a ~~~

X_1 and X_2 are each independently N, C, O, or S;

R_8 is H, halo, -OH, C_{1-6} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, -OH, $-NR_aR_b$, $-(CH_2)_n-O-R_c$, $-O-(C_{1-6}$ alkyl), $-S(O)_pR_e$, or $-C(O)-R_d$;

R_9 is H, C_{1-6} alkyl, substituted C_{1-6} alkyl, heterocyclyl, substituted heterocyclyl or R_{9a}, wherein R_{9a} is:



R_{9a}

the binding being achieved at the bond indicated by a ~~~

R_{10} and R_{11} are each independently H, halo, C_{1-6} alkoxy, substituted C_{1-6} alkoxy, $-NR_aR_b$, or -OH;

each R_a and R_b is independently H, C_{1-6} alkyl, substituted C_{1-6} alkyl, $-C(O)R_d$, C_{6-10} aryl;

each R_c is independently H, phosphate, diphosphate, triphosphate, C_{1-6} alkyl, or substituted C_{1-6} alkyl;

each R_d is independently H, halo, C_{1-6} alkyl, substituted C_{1-6} alkyl, C_{1-6} alkoxy, substituted C_{1-6} alkoxy, $-NH_2$, $-NH(C_{1-6}$ alkyl), -NH(substituted C_{1-6} alkyl), $-N(C_{1-6}$ alkyl)$_2$, $-N($substituted C_{1-6} alkyl)$_2$, C_{6-10} aryl, or heterocyclyl;

each R_e is independently H, C_{1-6} alkyl, substituted C_{1-6} alkyl, C_{6-10} aryl, substituted C_{6-10} aryl, heterocyclyl, or substituted heterocyclyl;

each R_f is independently H, C_{1-6} alkyl, substituted C_{1-6} alkyl, $-C(O)R_d$, phosphate, diphosphate, or triphosphate;

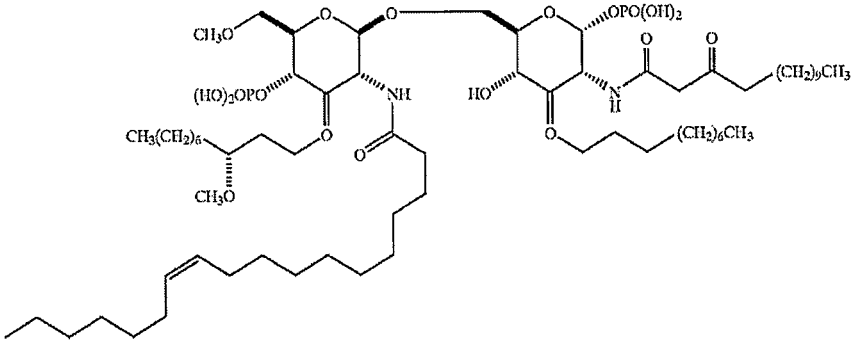
each n is independently 0, 1, 2, or 3;

each p is independently 0, 1, or 2; or

or (g) a pharmaceutically acceptable salt of any of (a) to (f), a tautomer of any of (a) to (f), or a pharmaceutically acceptable salt of the tautomer.

Q. Lipids linked to a phosphate-containing acyclic backbone

Adjuvants containing lipids linked to a phosphate-containing acyclic backbone include the TLR4 antagonist E5564 [136,137]:



R. Small molecule immunopotentiators (SMIPs)

SMIPs include:

- N2-methyl-1-(2-methylpropyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2,N2-dimethyl-1-(2-methylpropyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2-ethyl-N2-methyl-1-(2-methylpropyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2-methyl-1-(2-methylpropyl)-N2-propyl-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- 1-(2-methylpropyl)-N2-propyl-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2-butyl-1-(2-methylpropyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2-butyl-N2-methyl-1-(2-methylpropyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2-methyl-1-(2-methylpropyl)-N2-pentyl-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2-methyl-1-(2-methylpropyl)-N2-prop-2-enyl-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- 1-(2-methylpropyl)-2-[(phenylmethyl)thio]-1H-imidazo[4,5-c]quinolin-4-amine;
- 1-(2-methylpropyl)-2-(propylthio)-1H-imidazo[4,5-c]quinolin-4-amine ;
- 2-[[4-amino-1-(2-methylpropyl)-1H-imidazo[4,5-c]quinolin-2-yl](methyl)amino]ethanol;
- 2-[[4-amino-1-(2-methylpropyl)-1H-imidazo[4,5-c]quinolin-2-yl](methyl)amino]ethyl acetate;
- 4-amino-1-(2-methylpropyl)-1,3-dihydro-2H-imidazo[4,5-c]quinolin-2-one;
- N2-butyl-1-(2-methylpropyl)-N4,N4-bis(phenylmethyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;

- N2-butyl-N2-methyl-1-(2-methylpropyl)-N4,N4-bis(phenylmethyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2-methyl-1-(2-methylpropyl)-N4,N4-bis(phenylmethyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- N2,N2-dimethyl-1-(2-methylpropyl)-N4,N4-bis(phenylmethyl)-1H-imidazo[4,5-c]quinoline-2,4-diamine;
- 1-{4-amino-2-[methyl(propyl)amino]-1H-imidazo[4,5-c]quinolin-1-yl}-2-methylpropan-2-ol;
- 1-[4-amino-2-(propylamino)-1H-imidazo[4,5-c]quinolin-1-yl]-2-methylpropan-2-ol;
- N4,N4-dibenzyl-1-(2-methoxy-2-methylpropyl)-N2-propyl-1H-imidazo[4,5-c]quinoline-2,4-diamine.

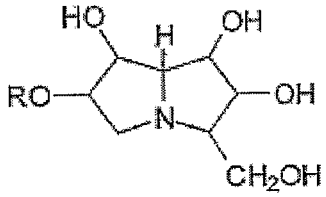
S. Proteosomes

One adjuvant is an outer membrane protein proteosome preparation prepared from a first Gram-negative bacterium in combination with a liposaccharide preparation derived from a second Gram-negative bacterium, wherein the outer membrane protein proteosome and liposaccharide preparations form a stable non-covalent adjuvant complex. Such complexes include "IVX-908", a complex comprised of *Neisseria meningitidis* outer membrane and lipopolysaccharides. They have been used as adjuvants for influenza vaccines [138].

T. Other adjuvants

Other substances that act as immunostimulating agents are disclosed in chapter 7 of ref. 53. references 53 and 58. Further useful adjuvant substances include:

- Methyl inosine 5'-monophosphate ("MIMP") [139].
- A polyhydroxlated pyrrolizidine compound [140], such as one having formula:



where R is selected from the group comprising hydrogen, straight or branched, unsubstituted or substituted, saturated or unsaturated acyl, alkyl (*e.g.* cycloalkyl), alkenyl, alkynyl and aryl groups, or a pharmaceutically acceptable salt or derivative thereof. Examples include, but are not limited to: casuarine, casuarine-6-α-D-glucopyranose, 3-*epi*-casuarine, 7-*epi*-casuarine, 3,7-di*epi*-casuarine, *etc.*

- A gamma inulin [141] or derivative thereof, such as algammulin.

SUBSTITUTE SHEET (RULE 26)

- Compounds disclosed in reference 142.
- Compounds disclosed in reference 143, including: Acylpiperazine compounds, Indoledione compounds, Tetrahydraisoquinoline (THIQ) compounds, Benzocyclodione compounds, Aminoazavinyl compounds, Aminobenzimidazole quinolinone (ABIQ) compounds [144,145], Hydrapthalamide compounds, Benzophenone compounds, Isoxazole compounds, Sterol compounds, Quinazilinone compounds, Pyrrole compounds [146], Anthraquinone compounds, Quinoxaline compounds, Triazine compounds, Pyrazalopyrimidine compounds, and Benzazole compounds [147].
- Loxoribine (7-allyl-8-oxoguanosine) [148].
- A formulation of a cationic lipid and a (usually neutral) co-lipid, such as aminopropyl-dimethyl-myristoleyloxy-propanaminium bromide-diphytanoylphosphatidyl-ethanolamine ("Vaxfectin™") or aminopropyl-dimethyl-bis-dodecyloxy-propanaminium bromide-dioleoylphosphatidyl-ethanolamine ("GAP-DLRIE:DOPE"). Formulations containing (±)-N-(3-aminopropyl)-N,N-dimethyl-2,3-bis(syn-9-tetradeceneyloxy)-1-propanaminium salts are preferred [149].

The invention may also comprise combinations of one or more of the adjuvants identified above. For example, the following combinations may be used as adjuvant compositions in the invention: (1) a saponin and an oil-in-water emulsion [150]; (2) a saponin (*e.g.* QS21) + a non-toxic LPS derivative (*e.g.* 3dMPL) [151]; (3) a saponin (*e.g.* QS21) + a non-toxic LPS derivative (*e.g.* 3dMPL) + a cholesterol; (4) a saponin (*e.g.* QS21) + 3dMPL + IL-12 (optionally + a sterol) [152]; (5) combinations of 3dMPL with, for example, QS21 and/or oil-in-water emulsions [153]; (6) SAF, containing 10% squalane, 0.4% Tween 80™, 5% pluronic-block polymer L121, and thr-MDP, either microfluidized into a submicron emulsion or vortexed to generate a larger particle size emulsion. (7) Ribi™ adjuvant system (RAS), (Ribi Immunochem) containing 2% squalene, 0.2% Tween 80, and one or more bacterial cell wall components from the group consisting of monophosphorylipid A (MPL), trehalose dimycolate (TDM), and cell wall skeleton (CWS), preferably MPL + CWS (Detox™); (8) one or more mineral salts (such as an aluminum salt) + a non-toxic derivative of LPS (such as 3dMPL); and (9) one or more mineral salts (such as an aluminum salt) + an immunostimulatory oligonucleotide (such as a nucleotide sequence including a CpG motif).

The compositions of the invention will preferably elicit both a cell mediated immune response as well as a humoral immune response in order to effectively address a uropathogenic infection. This immune response will preferably induce long lasting (*e.g.* neutralising) antibodies and a cell mediated immunity that can quickly respond upon exposure to MNEC-associated antigens.

Two types of T cells, CD4 and CD8 cells, are generally thought necessary to initiate and/or enhance cell mediated immunity and humoral immunity. CD8 T cells can express a CD8 co-receptor and are

commonly referred to as cytotoxic T lymphocytes (CTLs). CD8 T cells are able to recognized or interact with antigens displayed on MHC Class I molecules. CD4 T cells can express a CD4 co-receptor and are commonly referred to as T helper cells. CD4 T cells are able to recognize antigenic peptides bound to MHC class II molecules. Upon interaction with a MHC class II molecule, the CD4 cells can secrete factors such as cytokines. These secreted cytokines can activate B cells, cytotoxic T cells, macrophages, and other cells that participate in an immune response. Helper T cells or $CD4^+$ cells can be further divided into two functionally distinct subsets: TH1 phenotype and TH2 phenotypes which differ in their cytokine and effector function.

Activated TH1 cells enhance cellular immunity (including an increase in antigen-specific CTL production) and are therefore of particular value in responding to intracellular infections. Activated TH1 cells may secrete one or more of IL-2, IFN-γ, and TNF-β. A TH1 immune response may result in local inflammatory reactions by activating macrophages, NK (natural killer) cells, and CD8 cytotoxic T cells (CTLs). A TH1 immune response may also act to expand the immune response by stimulating growth of B and T cells with IL-12. TH1 stimulated B cells may secrete IgG2a.

Activated TH2 cells enhance antibody production and are therefore of particular value in responding to extracellular infections. Activated TH2 cells may secrete one or more of IL-4, IL-5, IL-6, and IL-10. A TH2 immune response may result in the production of IgG1, IgE, IgA and memory B cells for future protection.

An enhanced immune response may include one or more of an enhanced TH1 immune response and a TH2 immune response. An enhanced TH1 immune response may include one or more of an increase in CTLs, an increase in one or more of the cytokines associated with a TH1 immune response (such as IL-2, IFN-γ, and TNF-β), an increase in activated macrophages, an increase in NK activity, or an increase in the production of IgG2a. Preferably, the enhanced TH1 immune response will include an increase in IgG2a production. An enhanced TH2 immune response may include one or more of an increase in one or more of the cytokines associated with a TH2 immune response (such as IL-4, IL-5, IL-6 and IL-10), or an increase in the production of IgG1, IgE, IgA and memory B cells. Preferably, the enhanced TH2 immune resonse will include an increase in IgG1 production.

A TH1 immune response may be elicited using a TH1 adjuvant. A TH1 adjuvant will generally elicit increased levels of IgG2a production relative to immunization of the antigen without adjuvant. TH1 adjuvants suitable for use in the invention may include for example saponin formulations, virosomes and virus like particles, non-toxic derivatives of enterobacterial lipopolysaccharide (LPS), immunostimulatory oligonucleotides. Immunostimulatory oligonucleotides, such as oligonucleotides containing a CpG motif, are preferred TH1 adjuvants for use in the invention.

A TH2 immune response may be elicited using a TH2 adjuvant. A TH2 adjuvant will generally elicit increased levels of IgG1 production relative to immunization of the antigen without adjuvant. TH2

adjuvants suitable for use in the invention include, for example, mineral containing compositions, oil-emulsions, and ADP-ribosylating toxins and detoxified derivatives hereof. Mineral containing compositions, such as aluminium salts are preferred TH2 adjuvants for use in the invention.

Preferably, the invention includes a composition comprising a combination of a TH1 adjuvant and a TH2 adjuvant. Preferably, such a composition elicits an enhanced TH1 and an enhanced TH2 response *i.e.* an increase in the production of both IgG1 and IgG2a production relative to immunization without an adjuvant. Still more preferably, the composition comprising a combination of a TH1 and a TH2 adjuvant elicits an increased TH1 and/or an increased TH2 immune response relative to immunization with a single adjuvant (*i.e.* relative to immunization with a TH1 adjuvant alone or immunization with a TH2 adjuvant alone).

The immune response may be one or both of a TH1 immune response and a TH2 response. Preferably, immune response provides for one or both of an enhanced TH1 response and an enhanced TH2 response.

The enhanced immune response may be one or both of a systemic and a mucosal immune response. Preferably, the immune response provides for one or both of an enhanced systemic and an enhanced mucosal immune response. Preferably the mucosal immune response is a TH2 immune response. Preferably, the mucosal immune response includes an increase in the production of IgA.

The use of an aluminium hydroxide or aluminium phosphate adjuvant is particularly preferred, and antigens are generally adsorbed to these salts. Calcium phosphate is another preferred adjuvant.

The pH of compositions of the invention is preferably between 6 and 8, preferably about 7. Stable pH may be maintained by the use of a buffer. Where a composition comprises an aluminium hydroxide salt, it is preferred to use a histidine buffer [154]. The composition may be sterile and/or pyrogen-free. Compositions of the invention may be isotonic with respect to humans.

Compositions may be presented in vials, or they may be presented in ready-filled syringes. The syringes may be supplied with or without needles. A syringe will include a single dose of the composition, whereas a vial may include a single dose or multiple doses. Injectable compositions will usually be liquid solutions or suspensions. Alternatively, they may be presented in solid form (*e.g.* freeze-dried) for solution or suspension in liquid vehicles prior to injection.

Compositions of the invention may be packaged in unit dose form or in multiple dose form. For multiple dose forms, vials are preferred to pre-filled syringes. Effective dosage volumes can be routinely established, but a typical human dose of the composition for injection has a volume of 0.5ml.

Where a composition of the invention is to be prepared extemporaneously prior to use (*e.g.* where a component is presented in lyophilised form) and is presented as a kit, the kit may comprise two vials,

or it may comprise one ready-filled syringe and one vial, with the contents of the syringe being used to reactivate the contents of the vial prior to injection.

Thus the invention provides for a kit comprising a first component and a second component, wherein: the first component comprises one or more polypeptide, antibody, vesicle and/or nucleic acid of the invention; and the second component comprises one or more of the following: instructions for administering a composition to a patient, a syringe or other delivery device, an adjuvant, and/or a pharmaceutically acceptable formulating solution.

The invention also provides a delivery device (*e.g.* a syringe) pre-filled with the immunogenic compositions of the invention.

Immunogenic compositions used as vaccines comprise an immunologically effective amount of antigen(s), as well as any other components, as needed. By 'immunologically effective amount', it is meant that the administration of that amount to an individual, either in a single dose or as part of a series, is effective for treatment or prevention. This amount varies depending upon the health and physical condition of the individual to be treated, age, the taxonomic group of individual to be treated (*e.g.* non-human primate, primate, *etc.*), the capacity of the individual's immune system to synthesise antibodies, the degree of protection desired, the formulation of the vaccine, the treating doctor's assessment of the medical situation, and other relevant factors. It is expected that the amount will fall in a relatively broad range that can be determined through routine trials, and a typical quantity of each meningococcal saccharide antigen per dose is between 1μg and 10mg per antigen.

Pharmaceutical uses

The invention also provides a method of treating a patient, comprising administering to the patient a therapeutically effective amount of a composition of the invention. The patient may either be at risk from the disease themselves or may be a pregnant woman ('maternal immunisation' [155]).

The invention provides nucleic acid, polypeptide, vesicle or antibody of the invention for use as medicaments (*e.g.* as immunogenic compositions or as vaccines) or as diagnostic reagents. It also provides the use of nucleic acid, polypeptide, vesicle or antibody of the invention in the manufacture of: (i) a medicament for treating or preventing disease and/or infection caused by an ExPEC bacterium; (ii) a diagnostic reagent for detecting the presence of or of antibodies raised against an ExPEC bacterium; and/or (iii) a reagent which can raise antibodies against an ExPEC bacterium. Said ExPEC bacterium can be of any serotype or strain, but are preferably MNEC bacteria *e.g.* K1 serotype and/or B2 MLEE type.

The invention is useful for the prevention and/or treatment of diseases such as bacteremia, meningitis, a urinary tract infection, pyelonephritis and/or cystitis. The invention is particularly useful for the treatment of sepsis and/or meningitis

The patient is preferably a human. The human may be a child (*e.g.* aged between 0 and 18 years, or between 0-5 years), may be an adolescent (*e.g.* aged 15-19), an adult (*e.g.* aged 19-54) or may be elderly (*e.g.* 55 years or older). Female adolescents and adults are a preferred group of patients. A vaccine intended for children or adolescents may also be administered to adults *e.g.* to assess safety, dosage, immunogenicity, *etc.*

Other possible patient animals include dogs, which may be carriers of ExPEC [156,157].

One way of checking efficacy of therapeutic treatment involves monitoring infection after administration of the composition of the invention. One way of checking efficacy of prophylactic treatment involves monitoring immune responses against an administered polypeptide after administration. Immunogenicity of compositions of the invention can be determined by administering them to test subjects (*e.g.* children 12-16 months age, or animal models *e.g.* a murine model) and then determining standard parameters including ELISA titres (GMT) of IgG. These immune responses will generally be determined around 4 weeks after administration of the composition, and compared to values determined before administration of the composition. Where more than one dose of the composition is administered, more than one post-administration determination may be made. Efficacy may also be assessed using adult mice models of sepsis, mouse models of UTI , and passive protection from meningitis in infant rats.

Administration of polypeptide antigens is a preferred method of treatment for inducing immunity. Administration of antibodies of the invention is another preferred method of treatment. This method of passive immunisation is particularly useful for newborn children or for pregnant women. This method will typically use monoclonal antibodies, which will be humanised or fully human.

Compositions of the invention will generally be administered directly to a patient. Direct delivery may be accomplished by parenteral injection (*e.g.* subcutaneously, intraperitoneally, intravenously, intramuscularly, or to the interstitial space of a tissue), or by rectal, oral (*e.g.* tablet, spray), vaginal, topical, transdermal, transcutaneous, intranasal, sublingual, ocular, aural, pulmonary or other mucosal administration. Intramuscular administration to the thigh or the upper arm is preferred. Injection may be via a needle (*e.g.* a hypodermic needle), but needle-free injection may alternatively be used. A typical intramuscular dose is 0.5 ml.

The invention may be used to elicit systemic and/or mucosal immunity. Preferably the enhanced systemic and/or mucosal immunity is reflected in an enhanced TH1 and/or TH2 immune response. Preferably, the enhanced immune response includes an increase in the production of IgG1 and/or IgG2a and/or IgA.

Dosage treatment can be a single dose schedule or a multiple dose schedule. Multiple doses may be used in a primary immunisation schedule and/or in a booster immunisation schedule. A primary dose schedule may be followed by a booster dose schedule. In a multiple dose schedule the various doses

may be given by the same or different routes *e.g.* a parenteral prime and mucosal boost, a mucosal prime and parenteral boost, *etc.* Suitable timing between priming doses (*e.g.* between 4-16 weeks), and between priming and boosting, can be routinely determined. For example, a primary course of vaccination may include 1-10 separate doses, followed by other doses given at subsequent time intervals required to maintain and/or reinforce an immune response, for example, at 1-4 months for a second dose, and if needed, a subsequent dose or doses after several months.

Bacterial infections affect various areas of the body and so compositions may be prepared in various forms. For example, the compositions may be prepared as injectables, either as liquid solutions or suspensions. Solid forms suitable for solution in, or suspension in, liquid vehicles prior to injection can also be prepared (*e.g.* a lyophilised or a spray-freeze dried composition). The composition may be prepared for topical administration *e.g.* as an ointment, cream or powder. The composition be prepared for oral administration *e.g.* as a tablet or capsule, as a spray, or as a syrup (optionally flavoured). The composition may be prepared for pulmonary administration *e.g.* as an inhaler, using a fine powder or a spray. The composition may be prepared as a suppository or pessary. The composition may be prepared for nasal, aural or ocular administration *e.g.* as spray, drops, gel or powder [*e.g.* refs 158 & 159]. The composition may be in kit form, designed such that a combined composition is reconstituted just prior to administration to a patient. Such kits may comprise one or more antigens in liquid form and one or more lyophilised antigens.

Compositions of the invention may be administered to patients at substantially the same time as (*e.g.* during the same medical consultation or visit to a healthcare professional) other vaccines *e.g.* at substantially the same time as a measles vaccine, a mumps vaccine, a rubella vaccine, a MMR vaccine, a varicella vaccine, a MMRV vaccine, a diphtheria vaccine, a tetanus vaccine, a pertussis vaccine, a DTP vaccine, a conjugated *H.influenzae* type b vaccine, a human papillomavirus vaccine, an inactivated poliovirus vaccine, a hepatitis B virus vaccine, a pneumococcal conjugate vaccine, a meningococcal conjugate vaccine, *etc.* Similarlythey may be administered to patients at substantially the same time as (*e.g.* during the same medical consultation or visit to a healthcare professional) an antibiotic, and in particular an antibiotic compound active against MNEC.

Further antigenic components of compositions of the invention

The invention also provides a composition comprising a polypeptide or the invention and one or more of the following further antigens:

- a saccharide antigen from *N.meningitidis* serogroup A, C, W135 and/or Y (preferably all four), such as the oligosaccharide disclosed in ref. 160 from serogroup C [see also ref. 161] or the oligosaccharides of ref. 162.
- an antigen from *N.meningitidis* serogroup B such as those disclosed in refs. 163-171, *etc.*
- a saccharide antigen from *Streptococcus pneumoniae* [*e.g.* 172, 173, 174].
- an antigen from hepatitis A virus, such as inactivated virus [*e.g.* 175, 176].

– an antigen from hepatitis B virus, such as the surface and/or core antigens [*e.g.* 176, 177].
– a diphtheria antigen, such as a diphtheria toxoid [*e.g.* chapter 3 of ref. 178] *e.g.* the CRM_{197} mutant [*e.g.* 179].
– an antigen from hepatitis C virus [*e.g.* 180].
– an antigen from HIV [181]
– a tetanus antigen, such as a tetanus toxoid [*e.g.* chapter 4 of ref. 178].
– an antigen from *Bordetella pertussis*, such as pertussis holotoxin (PT) and filamentous haemagglutinin (FHA) from *B.pertussis*, optionally also in combination with pertactin and/or agglutinogens 2 and 3 [*e.g.* refs. 182 & 183].
– a saccharide antigen from *Haemophilus influenzae* B [*e.g.* 161].
– polio antigen(s) [*e.g.* 184, 185] such as IPV.
– measles, mumps and/or rubella antigens [*e.g.* chapters 9, 10 & 11 of ref. 178].
– varicella antigens.
– influenza antigen(s) [*e.g.* chapter 19 of ref. 178], such as the haemagglutinin and/or neuraminidase surface proteins. Influenza antigens may be derived from interpandemic (annual) flu strains. Influenza antigens may be derived from strains with the potential to cause a pandemic outbreak (i.e., influenza strains with new haemagglutinin compared to the haemagglutinin in currently circulating strains, or influenza strains which are pathogenic in avian subjects and have the potential to be transmitted horizontally in the human population, or influenza strains which are pathogenic to humans). Influenza antigens may be derived from viruses grown in eggs or cell culture.
– an antigen from *Moraxella catarrhalis* [*e.g.* 186].
– a saccharide antigen from *Streptococcus agalactiae* (group B streptococcus).
– an protein antigen from *Streptococcus agalactiae* (group B streptococcus) [*e.g.* 187, 188].
– an antigen from *N.gonorrhoeae* [*e.g.* 189-192].
– an antigen from *Chlamydia pneumoniae* [*e.g.* refs. 193 to 199] or a combination of antigens from *C.pneumoniae* [*e.g.* 200].
– an antigen from *Chlamydia trachomatis,* or a combination of antigens from *C.trachomatis* [*e.g.* 201].
– an antigen from *Porphyromonas gingivalis* [*e.g.* 202].
– rabies antigen(s) [*e.g.* 203] such as lyophilised inactivated virus [*e.g.* 204, RabAvert™].
– antigen(s) from a paramyxovirus such as respiratory syncytial virus (RSV [205, 206]) and/or parainfluenza virus (PIV3 [207]).
– an antigen from *Bacillus anthracis* [*e.g.* 208, 209, 210].
– an antigen from *Streptococcus pyogenes* (group A streptococcus) [*e.g.* 188,211, 212].
– an antigen from *Staphylococcus aureus* [*e.g.* 213].

- an antigen from a virus in the flaviviridae family (genus flavivirus), such as from yellow fever virus, Japanese encephalitis virus, four serotypes of Dengue viruses, tick-borne encephalitis virus, West Nile virus.
- a pestivirus antigen, such as from classical porcine fever virus, bovine viral diarrhoea virus, and/or border disease virus.
- a parvovirus antigen *e.g.* from parvovirus B19.
- a human papilloma virus (HPV) antigen [214]

The composition may comprise one or more of these further antigens.

Preferred *Gonococcal* antigens include one or more of ngs13 (OmpA), OmpH, ngs576 (peptidyl-prolyl cis/trans isomerase (PPIase) protein), ngs41 and ngs117.

Preferred HPV antigens include one or more of HPV 16, HPV 18, HPV 6 and HPV 11.

Preferred *Chlamydia trachomatis* antigens include one or more of: CT045, CT089, CT242, CT316, CT381. CT396, CT398, CT444, CT467, CT547, CT587, CT823, CT761 and specific combinations of these antigens as disclosed in WO 05/002619.

Preferred *Chlamydia pneumoniae* antigens include one or more of: CPn0324, Cpn0301, Cpn0482, Cpn0503, Cpn0525, Cpn0558, Cpn0584, Cpn0800, Cpn0979, Cpn0498, Cpn0300, Cpn0042, Cpn0013, Cpn450, Cpn0661, Cpn0557, Cpn0904, Clpn0795, Cpn0186 and Cpn0604 and specific combinations of these antigens as disclosed in WO 05/084306.

Preferred GBS antigens include one or more of GBS80, GBS 104, GBS 59, GBS 67, GBS 322 and GBS 276.

In another embodiment, antigens of the invention are combined with one or more additional, non-*E.coli* antigens suitable for use in a vaccine designed to protect females against genitourinary and/or sexually transmitted diseases. For example, the antigens may be combined with an antigen derived from the group consisting of *Streptococcus agalactiae, Chlamydia trachomatis, Neisseria gonorrhoeae,* papillomavirus and herpes simplex virus. Where human papillomavirus antigens are used, they may be from one or more of HPV 16, HPV 18, HPV 6 and/or HPV 11.

In another embodiment, the antigen combinations of the invention are combined with one or more additional, non-ExPEC antigens suitable for use in a vaccine designed to protect elderly or immunocompromised individuals. For example, the antigen combinations may be combined with an antigen derived from the group consisting of *Enterococcus faecalis, Staphylococcus aureus, Staphylococcus epidermis, Pseudomonas aeruginosa, Legionella pneumophila, Listeria monocytogenes, Neisseria meningitidies,* influenza, and parainfluenza virus ('PIV').

Toxic protein antigens may be detoxified where necessary (*e.g.* detoxification of pertussis toxin by chemical and/or genetic means [183]).

Where a diphtheria antigen is included in the composition it is preferred also to include tetanus antigen and pertussis antigens. Similarly, where a tetanus antigen is included it is preferred also to include diphtheria and pertussis antigens. Similarly, where a pertussis antigen is included it is preferred also to include diphtheria and tetanus antigens. DTP combinations are thus preferred.

Saccharide antigens are preferably in the form of conjugates. Carrier proteins for the conjugates include bacterial toxins (such as diphtheria toxoid or tetanus toxoid), the *N.meningitidis* outer membrane protein [215], synthetic peptides [216,217], heat shock proteins [218,219], pertussis proteins [220,221], protein D from *H.influenzae* [222,223], cytokines [224], lymphokines [224], *H.influenzae* proteins, hormones [224], growth factors [224], toxin A or B from *C.difficile* [225], iron-uptake proteins [226], artificial proteins comprising multiple human CD4+ T cell epitopes from various pathogen-derived antigens [227] such as the N19 protein [228], pneumococcal surface protein PspA [229], pneumolysin [230], *etc.* A preferred carrier protein is CRM197 protein [231].

Antigens in the composition will typically be present at a concentration of at least 1μg/ml each. In general, the concentration of any given antigen will be sufficient to elicit an immune response against that antigen.

Antigens are preferably adsorbed to an aluminium salt.

Nucleic acid immunisation

The immunogenic compositions described above include polypeptide antigens from MNEC. As an alternative to using proteins antigens in the immunogenic compositions of the invention, nucleic acid (preferably DNA *e.g.* in the form of a plasmid) encoding the antigen may be used, to give compositions, methods and uses based on nucleic acid immunisation. Nucleic acid immunisation is now a developed field (*e.g.* see references 232 to 239 *etc.*), and has been applied to many vaccines.

The nucleic acid encoding the immunogen is expressed *in vivo* after delivery to a patient and the expressed immunogen then stimulates the immune system. The active ingredient will typically take the form of a nucleic acid vector comprising: (i) a promoter; (ii) a sequence encoding the immunogen, operably linked to the promoter; and optionally (iii) a selectable marker. Preferred vectors may further comprise (iv) an origin of replication; and (v) a transcription terminator downstream of and operably linked to (ii). In general, (i) & (v) will be eukaryotic and (iii) & (iv) will be prokaryotic.

Preferred promoters are viral promoters *e.g.* from cytomegalovirus (CMV). The vector may also include transcriptional regulatory sequences (*e.g.* enhancers) in addition to the promoter and which interact functionally with the promoter. Preferred vectors include the immediate-early CMV enhancer/promoter, and more preferred vectors also include CMV intron A. The promoter is operably linked to a downstream sequence encoding an immunogen, such that expression of the immunogen-encoding sequence is under the promoter's control.

Where a marker is used, it preferably functions in a microbial host (*e.g.* in a prokaryote, in a bacteria, in a yeast). The marker is preferably a prokaryotic selectable marker (*e.g.* transcribed under the control of a prokaryotic promoter). For convenience, typical markers are antibiotic resistance genes.

The vector of the invention is preferably an autonomously replicating episomal or extrachromosomal vector, such as a plasmid.

The vector of the invention preferably comprises an origin of replication. It is preferred that the origin of replication is active in prokaryotes but not in eukaryotes.

Preferred vectors thus include a prokaryotic marker for selection of the vector, a prokaryotic origin of replication, but a eukaryotic promoter for driving transcription of the immunogen-encoding sequence. The vectors will therefore (a) be amplified and selected in prokaryotic hosts without polypeptide expression, but (b) be expressed in eukaryotic hosts without being amplified. This arrangement is ideal for nucleic acid immunization vectors.

The vector of the invention may comprise a eukaryotic transcriptional terminator sequence downstream of the coding sequence. This can enhance transcription levels. Where the coding sequence does not have its own, the vector of the invention preferably comprises a polyadenylation sequence. A preferred polyadenylation sequence is from bovine growth hormone.

The vector of the invention may comprise a multiple cloning site.

In addition to sequences encoding the immunogen and a marker, the vector may comprise a second eukaryotic coding sequence. The vector may also comprise an IRES upstream of said second sequence in order to permit translation of a second eukaryotic polypeptide from the same transcript as the immunogen. Alternatively, the immunogen-coding sequence may be downstream of an IRES.

The vector of the invention may comprise unmethylated CpG motifs *e.g.* unmethylated DNA sequences which have in common a cytosine preceding a guanosine, flanked by two 5' purines and two 3' pyrimidines. In their unmethylated form these DNA motifs have been demonstrated to be potent stimulators of several types of immune cell.

Vectors may be delivered in a targeted way. Receptor-mediated DNA therapy techniques are described in, for example, references 240 to 245. Therapeutic compositions containing a nucleic acid are administered in a range of about 100ng to about 200mg of DNA for local administration in a gene therapy protocol. Concentration ranges of about 500 ng to about 50 mg, about 1μg to about 2 mg, about 5μg to about 500μg, and about 20μg to about 100μg of DNA can also be used during a gene therapy protocol. Factors such as method of action (*e.g.* for enhancing or inhibiting levels of the encoded gene product) and efficacy of transformation and expression are considerations which will affect the dosage required for ultimate efficacy. Where greater expression is desired over a larger area of tissue, larger amounts of vector or the same amounts re-administered in a successive protocol

of administrations, or several administrations to different adjacent or close tissue portions may be required to effect a positive therapeutic outcome. In all cases, routine experimentation in clinical trials will determine specific ranges for optimal therapeutic effect.

Vectors can be delivered using gene delivery vehicles. The gene delivery vehicle can be of viral or non-viral origin (see generally references 246 to 249).

Viral-based vectors for delivery of a desired nucleic acid and expression in a desired cell are well known in the art. Exemplary viral-based vehicles include, but are not limited to, recombinant retroviruses (*e.g.* references 250 to 260), alphavirus-based vectors (*e.g.* Sindbis virus vectors, Semliki forest virus (ATCC VR-67; ATCC VR-1247), Ross River virus (ATCC VR-373; ATCC VR-1246) and Venezuelan equine encephalitis virus (ATCC VR-923; ATCC VR-1250; ATCC VR 1249; ATCC VR-532); hybrids or chimeras of these viruses may also be used), poxvirus vectors (*e.g.* vaccinia, fowlpox, canarypox, modified vaccinia Ankara, *etc.*), adenovirus vectors, and adeno-associated virus (AAV) vectors (*e.g.* see refs. 261 to 266). Administration of DNA linked to killed adenovirus [267] can also be employed.

Non-viral delivery vehicles and methods can also be employed, including, but not limited to, polycationic condensed DNA linked or unlinked to killed adenovirus alone [*e.g.* 267], ligand-linked DNA [268], eukaryotic cell delivery vehicles cells [*e.g.* refs. 269 to 273] and nucleic charge neutralization or fusion with cell membranes. Naked DNA can also be employed. Exemplary naked DNA introduction methods are described in refs. 274 and 275. Liposomes (*e.g.* immunoliposomes) that can act as gene delivery vehicles are described in refs. 276 to 280. Additional approaches are described in references 281 & 282.

Further non-viral delivery suitable for use includes mechanical delivery systems such as the approach described in ref. 282. Moreover, the coding sequence and the product of expression of such can be delivered through deposition of photopolymerized hydrogel materials or use of ionizing radiation [*e.g.* refs. 283 & 284]. Other conventional methods for gene delivery that can be used for delivery of the coding sequence include, for example, use of hand-held gene transfer particle gun [285] or use of ionizing radiation for activating transferred genes [283 & 286].

Delivery DNA using PLG {poly(lactide-co-glycolide)} microparticles is a particularly preferred method *e.g.* by adsorption to the microparticles, which are optionally treated to have a negatively-charged surface (*e.g.* treated with SDS) or a positively-charged surface (*e.g.* treated with a cationic detergent, such as CTAB).

General

The term "comprising" encompasses "including" as well as "consisting" *e.g.* a composition "comprising" X may consist exclusively of X or may include something additional *e.g.* X + Y.

The term "about" in relation to a numerical value x means, for example, $x\pm10\%$.

The word "substantially" does not exclude "completely" *e.g.* a composition which is "substantially free" from Y may be completely free from Y. Where necessary, the word "substantially" may be omitted from the definition of the invention.

The N-terminus residues in the amino acid sequences in the sequence listing are generally given as the amino acid encoded by the first codon in the corresponding nucleotide sequence. Where the first codon is not ATG (*e.g.* SEQ ID NOs: 1, 7, 19, 39, 43, 49, 51, 55, 63, 73, 119, 127, 129, 137, 143, 145, 147, 149, 155, 159, 165, 173, 181, 183, 205, 209, 219, 221, 229, 235, 247, 263, 269, 271, 297, 303, 325, 327, 341, 345, 359, 363, 373, 395, 401, 413, 443, 447, 453, 459, 463, 465, 469, 473, 477, 479, 495, 505, 507, 517, 527, 533, 535, 537, 539, 549, 569, 575, 579, 581, 583, 587, 591, 593, 599, 613, 621, 635, 637, 643, 655, 661, 665, 669, 671, 681, 683, 687, 693, 707, 709, 721, 723, 729, 743, 757, 763, 765, 769, 781, 791, 793, 813, 817, 823, 837, 839, 855, 861, 865, 881, 885, 897, 907, 909, 911, 917, 921, 941, 949, 957, 965, 975, 977, 979, 981, 983, 989, 993, 997, 1001, 1005, 1011, 1015, 1017, 1019, 1027, 1029, 1033, 1037, 1043, 1051, 1053, 1073, 1087, 1097, 1101, 1103, 1107, 1113, 1115, 1117, 1121, 1123, 1135, 1143, 1147, 1149, 1175, 1181, 1227, 1263, 1271, 1287, 1295, 1305, 1307, 1311, 1317, 1323, 1331, 1341, 1345, 1349, 1351, 1355, 1359, 1363, 1373, 1375, 1383, 1399, 1411, 1415, 1417, 1423, 1433, 1451, 1477, 1483, 1485, 1493, 1495, 1501, 1503, 1511, 1519, 1521, 1525, 1529, 1553, 1559, 1579, 1585, 1603, 1609, 1611, 1619, 1621, 1623, 1629, 1631, 1643, 1653, 1669, 1675, 1677, 1687, 1693, 1705, 1713, 1717, 1727, 1739, 1751, 1763, 1769, 1785, 1789, 1799, 1801, 1817, 1819, 1825, 1827, 1829, 1831, 1833, 1839, 1857, 1867, 1911, 1919, 1925, 1929, 1939, 1947, 1955, 1957, 1979, 1981, 1985, 1989, 1993, 1995, 2003, 2005, 2009, 2027, 2035, 2037, 2047, 2049, 2059, 2063, 2079, 2093, 2123, 2135, 2139, 2141, 2163, 2165, 2173, 2177, 2189, 2195, 2197, 2203, 2209, 2211, 2241, 2247, 2275, 2291, 2321, 2327, 2357, 2361, 2373, 2377, 2379, 2397, 2399, 2405, 2433, 2437, 2443, 2447, 2451, 2455, 2457, 2487, 2491, 2503, 2505, 2507, 2513, 2515, 2521, 2541, 2545, 2549, 2553, 2565, 2577, 2579, 2591, 2613, 2623, 2629, 2631, 2633, 2635, 2639, 2641, 2649, 2657, 2659, 2661, 2663, 2665, 2667, 2669, 2671, 2681, 2687, 2689, 2699, 2701, 2705, 2713, 2719, 2721, 2729, 2735, 2743, 2745, 2759, 2781, 2785, 2787, 2789, 2795, 2801, 2809, 2813, 2815, 2823, 2825, 2845, 2847, 2869, 2885, 2891, 2897, 2905, 2907, 2911, 2913, 2915, 2925, 2939, 2945, 2947, 2975, 2993, 3015, 3043, 3055, 3061, 3063, 3075, 3107, 3117, 3127, 3131, 3175, 3179, 3191, 3193, 3207, 3209, 3213, 3221, 3229, 3243, 3253, 3259, 3261, 3267, 3283, 3289, 3307, 3313, 3331, 3337, 3339, 3353, 3357, 3361, 3367, 3379, 3381, 3383, 3411, 3419, 3429, 3433, 3435, 3437, 3445, 3449, 3453, 3471, 3491, 3501, 3507, 3515, 3559, 3563, 3571, 3573, 3577, 3579, 3583, 3595, 3607, 3619, 3621, 3623, 3625, 3629, 3633, 3635, 3637, 3663, 3671, 3679, 3685, 3687, 3699, 3701, 3707, 3713, 3721, 3723, 3739, 3741, 3743, 3759, 3763, 3777, 3797, 3807, 3811, 3821, 3829, 3833, 3855, 3857, 3863, 3865, 3867, 3869, 3873, 3881, 3891, 3893, 3901, 3919, 3925, 3931, 3937, 3949, 3951, 3955, 3959, 3969, 3973, 3981, 3991, 4003, 4013, 4029, 4033, 4049, 4057, 4069, 4071, 4077, 4081, 4089, 4107, 4131, 4139, 4171, 4193, 4195, 4199, 4201, 4223, 4225, 4245, 4249, 4273, 4279, 4281, 4287, 4293, 4301, 4319, 4321, 4327, 4337, 4351, 4353, 4361, 4363, 4365, 4369, 4377, 4379, 4387, 4395, 4403, 4411, 4417, 4423, 4429, 4443, 4463, 4479, 4483, 4485, 4493, 4495, 4523, 4527, 4529, 4541, 4549, 4553, 4563, 4577, 4583, 4585, 4595, 4619, 4635, 4651, 4677, 4683, 4685, 4699, 4703, 4709, 4711, 4719, 4751, 4753, 4761, 4789, 4803, 4805, 4819, 4829, 4833, 4837, 4839, 4847, 4851, 4857, 4863, 4869, 4887, 4891, 4893, 4909, 4925, 4927, 4931, 4935, 4939, 4943, 4949, 4957, 4963, 4965, 4973, 5019, 5033, 5063, 5073, 5081, 5083, 5085, 5089, 5093, 5113, 5167, 5179, 5183, 5193, 5209, 5211, 5213, 5227, 5231, 5237, 5245, 5273, 5281, 5283, 5297, 5299, 5301, 5305, 5309, 5329, 5333, 5347, 5353, 5365, 5367, 5369, 5385, 5389, 5401, 5435, 5437, 5439, 5453, 5465, 5475, 5515, 5517, 5525, 5543, 5545, 5559, 5571, 5605, 5611, 5619, 5639, 5651, 5655, 5665, 5685, 5701, 5715, 5761, 5769, 5771, 5775, 5781, 5793, 5795, 5801, 5817, 5819, 5831, 5855, 5861, 5865, 5873, 5887, 5889, 5909, 5911, 5927, 5945, 5949, 5957, 5959, 5965, 5973, 5987, 5997, 6003, 6013, 6015, 6023, 6025, 6027, 6037, 6063, 6091, 6093, 6095, 6097, 6111, 6117, 6119, 6135, 6143, 6147, 6165, 6177, 6187, 6189, 6191, 6195, 6197, 6199, 6203, 6223, 6227, 6229, 6237, 6245, 6247, 6249, 6253, 6255, 6259, 6267, 6297, 6305, 6311, 6317, 6345, 6361, 6389, 6419, 6421, 6435, 6457, 6461, 6463, 6467, 6471, 6487, 6499, 6535, 6553, 6559, 6561, 6565, 6617, 6631, 6633, 6643, 6677, 6699, 6707, 6733, 6745, 6781, 6783, 6789, 6799, 6813, 6843, 6847, 6851, 6861,

6885, 6893, 6899, 6901, 6905, 6915, 6917, 6919, 6933, 6941, 6943, 6957, 6961, 6967, 6973, 6985, 6993, 6995, 7021, 7023, 7045, 7047, 7051, 7063, 7065, 7069, 7077, 7085, 7089, 7091, 7097, 7099, 7107, 7113, 7123, 7129, 7131, 7167, 7191, 7199, 7219, 7223, 7241, 7247, 7263, 7277, 7289, 7309, 7339, 7345, 7383, 7401, 7409, 7411, 7413, 7429, 7439, 7443, 7455, 7459, 7461, 7465, 7477, 7489, 7497, 7499, 7513, 7523, 7525, 7527, 7533, 7549, 7555, 7557, 7567, 7581, 7601, 7611, 7615, 7617, 7623, 7633, 7641, 7651, 7653, 7659, 7665, 7687, 7693, 7701, 7709, 7723, 7727, 7779, 7789, 7797, 7809, 7849, 7859, 7869, 7877, 7885, 7891, 7893, 7905, 7907, 7917, 7929, 7933, 7937, 7943, 7945, 7951, 7953, 7969, 7971, 8015, 8017, 8027, 8055, 8059, 8061, 8069, 8107, 8137, 8145, 8149, 8151, 8153, 8171, 8179, 8217, 8219, 8231, 8239, 8245, 8247, 8261, 8269, 8301, 8313, 8341, 8365, 8371, 8381, 8387, 8393, 8421, 8447, 8453, 8455, 8457, 8461, 8465, 8471, 8493, 8501, 8505, 8515, 8523, 8531, 8545, 8575, 8579, 8581, 8617, 8645, 8647, 8655, 8667, 8677, 8679, 8683, 8689, 8691, 8697, 8709, 8715, 8721, 8727, 8731, 8739, 8745, 8775, 8793, 8797, 8807, 8815, 8823, 8827, 8833, 8859, 8863, 8869, 8889, 8899, 8901, 8909, 8913, 8915, 8929, 8933, 8935, 8949, 8951, 8955, 8967, 8993, 8995, 8997, 9003, 9009, 9013, 9019, 9033, 9037, 9061, 9065, 9067, 9079, 9101, 9103, 9123, 9153, 9157, 9163, 9185, 9189, 9197, 9201, 9223, 9225, 9227, 9241, 9243, 9247, 9273, 9275, 9281, 9297, 9313, 9321, 9331, 9339, 9369, 9383, 9385, 9387, 9409, 9413, 9435, 9449, 9469, 9471, 9491, 9495, 9497, 9499, 9503, 9527, 9529, 9545, 9547, 9557, 9559, 9565, 9577, 9589, 9599, 9601, 9603, 9605, 9607, 9621, 9633, 9635, 9653, 9655, 9663, 9681, 9701, 9705, 9717, 9731, 9747, 9765, 9797, 9807, 9809, 9811, 9831, 9851, 9853, 9855, 9875, 9899, 9915, 9929, 9931, 9939, 9941, 9945, 9949, 9953, 9959, 9989), it will be understood that it will be translated as methionine when the codon functions as a start codon, but will be translated as the indicated non-Met amino acid when the sequence is at the C-terminus of a fusion partner. The invention specifically discloses and encompasses each of the amino acid sequences of the sequence listing having a N-terminus methionine residue (*e.g.* a formyl-methionine residue) in place of any indicated non-Met residue (*e.g.* for SEQ ID NOS: 236, 662, 758, 770, 782, 792, 838, 918, 1182, 1312, 1374, 1632, 2064, 2378, 2400, 2456, 2516, 2636, 2670, 2682, 2688, 2744, 3384, 3702, 3714, 4058, 4678, 4704, 4804, 4806, 4848, 6026, 6112, 7022, 7242, 7710, 8582, 9682). It also specifically discloses and encompasses each of the amino acid sequences of the sequence listing starting at any internal methionine residues in the sequences.

As indicated in the above text, nucleic acids and polypeptides of the invention may include sequences that:

(a) are identical (*i.e.* 100% identical) to the sequences disclosed in the sequence listing;

(b) share sequence identity with the sequences disclosed in the sequence listing;

(c) have 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10 single nucleotide or amino acid alterations (deletions, insertions, substitutions), which may be at separate locations or may be contiguous, as compared to the sequences of (a) or (b); and

(d) when aligned with a particular sequence from the sequence listing using a pairwise alignment algorithm, a moving window of x monomers (amino acids or nucleotides) moving from start (N-terminus or 5') to end (C-terminus of 3'), such that for an alignment that extends to p monomers (where $p>x$) there are $p-x+1$ such windows, each window has at least $x \cdot y$ identical aligned monomers, where: x is selected from 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 150, 200; y is selected from 0.50, 0.60, 0.70, 0.75, 0.80, 0.85, 0.90, 0.91, 0.92, 0.93, 0.94, 0.95, 0.96, 0.97, 0.98, 0.99; and if $x \cdot y$ is is not an integer then it is rounded up to the nearest integer. The preferred pairwise alignment algorithm is the Needleman-Wunsch global alignment

algorithm [287], using default parameters (*e.g.* with Gap opening penalty = 10.0, and with Gap extension penalty = 0.5, using the EBLOSUM62 scoring matrix). This algorithm is conveniently implemented in the *needle* tool in the EMBOSS package [288].

The nucleic acids and polypeptides of the invention may additionally have further sequences to the N-terminus/5' and/or C-terminus/3' of these sequences (a) to (d).

The practice of the present invention will employ, unless otherwise indicated, conventional methods of chemistry, biochemistry, molecular biology, immunology and pharmacology, within the skill of the art. Such techniques are explained fully in the literature. See, *e.g.*, references 289-296, *etc.*

EXPERIMENTAL

Below are examples of specific embodiments or modes for carrying out the present invention. The examples are offered for illustrative purposes only, and are not intended to limit the scope of the present invention in any way.

Efforts have been made to ensure accuracy with respect to numbers used (e.g., amounts, temperatures, etc.), but some experimental error and deviation should, of course, be allowed for.

MODES FOR CARRYING OUT THE INVENTION

MNEC strain IHE3034

IHE3034 is a known *E.coli* strain of the MNEC pathotype. Table 1 of reference 297 reports that IHE3034 is classified as O18:K1:H7/9 serotype, and falls into ECOR group B2. Known virulence-associated genes on horizontally transferred DNA elements are *sfaII, ibeA, iro, kps* (group II), *fyuA* and *malX*. It also carries the *cdt* gene cluster coding for the cytolethal distending toxin.

Sequencing of *E.coli* K1 strain IHE3034 led to 283 contigs. These are given as SEQ ID NOs 9991 to 10273, arranged in descending order of length.

Analysis of the genome sequence of *E.coli* K1 strain IHE3034 has identified 4995 open reading frames (ORFs), which are referred to by the nomenclature *ORFnnnnn*, where *nnnnn* is a number between 00001 and 04995. Sequences for these ORFs are given as SEQ ID NOs: 1 to 9990, with odd-numbered SEQ ID NOs being DNA sequences, and even-numbered IDs being amino acid sequences. The *nnnnn* numbering can be converted to the SEQ ID NO: numbering of the sequence listing as follows: for an amino acid sequence, SEQ ID NO: = *nnnnn* × 2; for a nucleotide sequence, SEQ ID NO: = [*nnnnn* × 2] – 1. Thus *ORF01234* is found as SEQ ID NOs: 2467 & 2468, as shown in Table 1.

Initial functional annotation of the 4995 ORFs is given in Table 1.

Table 3 shows the ORFs which have low homology with commensal strain ORFs (1194 in total). These ORFs are preferred for giving specificity to pathological *E.coli* strains *vs.* commensal strains, both in relation to nucleic acid testing and in relation to immunological cross-reactity. Potential pathogenicity islands are located in the ranges ORF00028-70, ORF000330-353, ORF00655-687, ORF00883-910, ORF01031-1058, ORF1078-1119, ORF1186-1228, ORF01313-1376, ORF01479-1514, ORF01523-1543, ORF01550-1578, ORF01810-1865, ORF02295-02315, ORF02351-2375, ORF02382-2405, ORF02436-2472, ORF02788-02816, ORF02844-2891, ORF03011-3056, ORF03340-3365, ORF03499-3522, ORF04416-4439, ORF04661-4679, ORF04915-4930, and ORF04946-4966.

Based on various criteria applied by the inventors, a subset of 142 of the 4995 ORFs (2.8%) has been selected for immunogenic use. These 142 ORFs are listed in Table 2. The criteria for selection of the subset include, but are not limted to: low homology with ORFs from commensal *E.coli* strains; length >100aa; and suitable cellular localisation (shown at bottom of Table 2).

The genes encoding these 142 proteins are cloned, expressed in bacteria (*e.g.* in a non-pathogenic laboratory *E.coli* host, or in a *Bacillus* such as *B.subtilis* or *B.megaterium*), purified, and then are used to immunise test animals (*e.g.* mice). The serum raised in the mice are then analysed in Western blot, ELISA and FACS assays, and are further tested in both *in vitro* and *in vivo* experiments. Suitable *in vitro* experiments include testing the ability of antibodies to induce complement-mediated bacterial killing and/or opsonophagocytosis activity, to block binding of MNEC strains (or the purified antigen) to human epithelial cells or other cell lines, and/or to inhibit adhesion/invasion of *E.coli* bacteria (*e.g.* K1 strain) to brain microvascular endothelial cells (BMEC). Suitable *in vivo* experiments for testing efficacy against bacteremia and meningitis include active and/or passive systemic immunisations and challenge in 5-day-old rats challenged with *E.coli* K1 strain, and immunisation and intraperitoneal infection of adult mice with MNEC strains.

The importance of the proteins to the bacterial life-cycle can be tested by creating isogenic knockout mutants. The mutants can also be used to ensure that sera raised by an antigen are specific for that antigen. Microarrays are used to study expression patterns. Conservation and/or variability is assessed by sequencing the genes from multiple different ExPEC strains.

Assays were carried out in order to select predicted surface-exposed proteins, which are specific for MNEC strains and absent in non-pathogenic strains (commensal and laboratory strains). Once selected these proteins are expressed and purified and used to immunize mice.

It is known from reference 43 that a mutation in any of the tol-pal genes of *E.coli* results in the formation of vesicles containing native outer membrane proteins. By comparing the proteins present in vesicles of MNEC strains and non-pathogenic strains it is possible to select a small group of proteins that could be used as potential antigens.

Lambda red-mediated gene manipulation in commensal and pathogenic E.coli

This method is a rapid PCR-based method used to inactivate the tolR gene from the wild-type *E.coli* strains [298]. Briefly, the first step consists in amplifying independently the upstream and downstream regions of the target gene (tolR) and the resistance marker cassette. The two PCR products obtained in step 1 are mixed with the amplification producer of the AB cassette at equimolar concentrations and submitted to a second round of PCR (a three way PCR) to generate a resistance marker cassette flanked by upstream and downstream 500bp (or more) regions homologous to the target gene. In the third step, large amounts (1μg) of the desired linear DNA are electroporated into lamda-red competent cells.

Vesicle Preparation

1. Vesicle preparation by precipitation with TCA

LB media was inoculated with bacteria grown on plates and incubated overnight at 37°C under gentle shaking. The culture was used to inoculate 200ml of LB at OD600 0.1. Bacteria were grown to OD600 0.4 (or as specified). Culture was centrifuged for 10 minutes at 4000 x g and the supernatant was filtered through a 0.22mm filter to remove residual bacteria.

The same experiments were also performed under iron limiting conditions by adding Dipyridyl (0.25mM) to the LB media.

Precipitation was performed by adding to the culture supernatant 10% final of a solution at 100% (w/v) TCA, 0.4% (w/v) deoxycholate. The precipitation was allowed to proceed for 30 minutes at 4°C. Precipitate was recovered by 10 minutes centrifugation at 20000 x g at 4°C. The pellet was washed once with 10% TCA (w/v) and twice with absolute ethanol. The pellet was dried with speed vac, and stored at -20°C.

The wild type and mutated strains were subjected to SDS polyacrylamide gel electrophoresis from which it could be observed that there were many more bands in the supernatant of the mutated strains than the wildtype strains. Randomly picked bands demonstrated that all the proteins in the supernatant were membrane proteins.

2. Vesicle preparation by ultracentrifugation

Culture supernatant was ultracentrifuged at 200000 x g for 2 hours at 4°C. The pellet was washed with PBS, resuspended in PBS, and stored at -20°C.

3. Guanidinium denaturation of the vesicles

Prior to the guanidinium denaturation, Vesicles were precipitated with ethanol. 10μg of OMV in PBS were precipitate by adding cold absolute ethanol to 90% final. Precipitation was allowed to proceed for 20 minutes at –20°C. Precipitate was recovered by 10 minutes centrifugation at 13000 x g. Pellet was resuspended with 50ml, 6M guanidinium, 15mM DTT, 200mM Tris-HCl, pH 8.0.

Denaturation was allowed to proceed for 60 minutes at 60°C. Prior to digestion, solution was diluted 1/8 with a solution of 1.5M Tris pH 8.0 and 5mg of trypsin were added to the diluted solution. Digestion was allowed to proceed overnight at 37°C. Reaction was stopped by adding 0.1% final of formic acid. Peptides were extracted using Oasis extraction cartridges. Peptides were analyzed by LC coupled MS-MS.

4. Surface digestion

5mg of trypsin were added to 10mg of vesicles in PBS and incubated at 37°C for 3 hours. Reaction was stopped by adding 0,1% final of formic acid. Peptides were recovered by filtration through a 30Kda cut-off filter and extracted with Oasis extraction cartridge. Peptides were analyzed with LC coupled MSMS.

VESICLE ANALYSIS

Protein quantification

Proteins were quantified with the Bradford method, using the BSA as standard.

SDS-PAGE

Samples were analyzed with a sodium dodecyl sulfate (SDS) 4-12% polyacrylamide gel, using a Mini-Protean II electrophoresis apparatus. Samples were suspended in SDS sample buffer (0.06 M Tris-HCl pH 6.8, 10% (v/v) glycerol, 2% (w/v) SDS, 5% (v/v) 2-mercaptoethanol, 10 mg/ml bromophenol blue) and heated to 100°C for 5 min before SDS-polyacrylamide gel electrophoreis. After the run, gels were stained with Coomassie Blue

MALDI-TOF mass spectrometry.

Protein bands or spots were excised from gels, washed with 50 mM ammonium bicarbonate/acetonitrile (50/50, v/v), and dried with a Speed-Vac centrifuge (Savant). The dried spots were digested at 37°C for 2 h by adding 7 to 10 ml of a solution containing 5 mM ammonium bicarbonate, 0.012 mg of sequencing-grade trypsin. After digestion 0.6 ml were loaded on a matrix pre-spotted target and air-dried. Spots were washed with 0.6ml of a solution of 70% ethanol, 0.1% trifluoracetic acid. Mass spectra were acquired on an ultraflex MALDI TOF mass spectrometer. Spectra were externally calibrated by using a combination of standards pre-spotted on the target. Protein identification was carried out by both automatic and manual comparisons of experimentally generated monoisotopic peaks of peptides in the mass range of 700 to 3,000 Da with computer-generated fingerprints, using the Mascot program.

Bi-dimensional electrophoresis

200mg of vesicles were resuspended in an Immobiline re-swelling solution (7M urea, 2M thiourea, 2% (w/v) CHAPS (2% w/v) ASB14, 2% (v/v) IPG buffer pH 3–10 NL, 2mM TBP, 65mM DTT), and adsorbed overnight on 7 cm Immobiline DryStrips (pH 3–10 NL). Proteins were then separated by

2D electrophoresis. The first dimension was run using a IPGphor Isoelectric Focusing Unit, applying sequentially 150 V for 35 minutes, 500 V for 35 minutes, 1,000 V for 30 minutes, 2,600 V for 10 minutes, 3,500 V for 15 minutes, 4,200 V for 15 minutes, and finally 5,000 V to reach 10kVh. For the second dimension, the strips were equilibrated by two 10 minute -incubations in 4 M urea, 2 M thiourea, 30% glycerol, 2% SDS, 5mM TBP, 50Mm Tris HCl pH 8.8, 2.5% acrylamide, Bromo phenol Blue 0.2%: Proteins were then separated on linear 4-12 % precasted polyacrylamide gels.

Gels were stained with colloidal Coomassie Blue and scanned with a Personal Densitometer SI. Images were analyzed with Image Master 2D Elite software.

Nano-LC/MS/MS

Peptides were separated by nano-LC on a CapLC HPLC system connected to a Q-ToF Micro ESI mass spectrometer equipped with a nanospray source. Samples were loaded onto an Atlantis C18 NanoEase column (100μm i.d. x 100mm), through a C18 trap column (300μm i.d. x 5 mm). Peptides were eluted with a 50-min gradient from 2% to 60% of 95% ACN, in a solution of 0.1% formic acid at a flow rate of 400 nl/minute. The eluted peptides were subjected to an automated data-dependent acquisition program, using the MassLynx software, version 4.0, where a MS survey scan was used to automatically select multi-charged peptides over the m/z range of 400-2,000 for further MS/MS fragmentation. Up to three different components where subjected to MS/MS fragmentation at the same time. After data acquisition, the individual MS/MS spectra were combined, smoothed and centroided by MassLynx. Search and identification of peptides were performed in batch mode with a licensed version of MASCOT. The MASCOT search parameters were: (1) species: ExPEC (2) allowed number of missed cleavages (only for trypsin digestion): 6; (3) variable post-translational modifications: methionine oxidation; (4) peptide tolerance: ±500 ppm; (5) MS/MS tolerance: ±0.3 Da and (6): peptide charge: from +1 to +4. As for the previous platform, only significant hits as defined by MASCOT probability analysis were considered. The score thresholds for acceptance of protein identifications from at least one peptide were set by MASCOT as 18 for trypsin digestion and 36 for proteinase K digestion.

Results

As a result of the above analyses, 10 further preferred antigens were identified. Namely orf03526 (SEQ ID No: 7051 + 7052), orf01339 (SEQ ID No: 2677 + 2678), orf00256 (SEQ ID No: 511 + 512), orf01346 (SEQ ID No: 2691 + 2692), orf04084 (SEQ ID No: 8167 + 8168), orf02374 (SEQ ID No: 4747 + 4748), orf03502 (SEQ ID No: 7003 + 7004), orf02298 (SEQ ID No: 4595 + 4596), orf01228 (SEQ ID No: 2455 + 2456), orf01227 (SEQ ID No: 2453 + 2454), orf02314 (SEQ ID NO: 4627 + 4628) and orf02850 (SEQ ID NO: 5699 + 5700). These are listed in Table 4 where the identities of these proteins to proteins in the UPEC strain CFT073 are also given. Further preferred antigens are those which display greater than 60% identity to preferred antigens from the CFT073

strain which were identified using the same methods as above. These preferred antigens are orf04282 (SEQ ID No: 8563 + 8564), orf01364 (SEQ ID No: 2727 + 2728), orf04936 (SEQ ID No: 9871 + 9872), orf02336 (SEQ ID No: 4671 + 4672), orf02840 (SEQ ID No: 5679 + 5680), orf00267 (SEQ ID No: 533 + 534), orf01611 (SEQ ID No: 3221 + 3222), orf01613 (SEQ ID No: 3225 + 3226) and orf03502 (SEQ ID No: 7003 + 7004).

ANTIGEN ANALYSIS

Mouse Model of Systemic Infection

To screen a large number of antigens selected by comparative genome analysis between pathogenic and non pathogenic *E.coli* strains, a protection model based on a classical virulence assay has been established.

The experimental model (immunization and infection) uses 5 week old - CD1 outbreed mice which are challenged with intraperitoneal inoculation of virulent IHE3034 *E.coli* strain. The challenge dose has been experimentally determined as the amount of bacteria able to kill 80% of adult mice within 72 hours and corresponds to $1x10^7$ cfu/mouse for the IHE3034 strain.

Two proteins, described as virulence factors and potential protective antigens were used as positive controls. These proteins are the IbeA [299] and the IroN (SEQ ID No:2691, 2692 and refs 300,301). The recombinant proteins were expressed and used in the immunization assays.

Immunization Protocol

Mice are immunized three times by subcutaneous injection of 150µl of protein solution using freund's adjuvants as shown in the table below:

	Control mice:	**Immunized mice:**
Day 0	75 µl of saline solution 75 µl of complete freund's adjuvant	75 µl of protein solution (**20µg**) 75 µl of complete freund's adjuvant
Day 21	75 µl of saline solution 75 µl of incomplete freund's adjuvant	75 µl of protein solution (**20µg**) 75 µl of incomplete freund's adjuvant
Day 35	75 µl of saline solution 75 µl of incomplete freund's adjuvant	75 µl of protein solution (**20µg**) 75 µl of incomplete freund's adjuvant

Blood samples are colleccted the day before the first immunization (preimmune serum), at day 34 and 48 (day before challenge). Sera from immunized animals are tested by western blot and ELISA to determine the antibodies titer.

Challenge

At day 48 *E.coli* IHE3034 strain is streaked on LB agar plate from frozen stock and incubated overnight (ON) at 37° C in incubator. At Day 49 the ON plate-culture is used to inoculate 50 ml of LB medium to have an $O.D._{600}$ = 0.1, and grown for 1.5 hours at 37°C under agitation until the

bacterial culture reaches an $O.D._{600}$ = 0.6 corresponding to $5x10^8$ cfu/ml for the IHE3034 strain. The culture is diluted in physiological solution until the concentration of bacteria is $1x10^8$ /ml (typically 2ml of bacterial culture is diluted in 8ml of physiological solution) and plated using a standard plate count method to verify the inoculum. 100µl of the cell suspension containing $1x10^7$ IHE3034 bacteria is injected intraperitoneally, using a 1ml syringe, to control and immunized mice. The number of deaths in each animal group at 24, 48 and 72 hours after infection are recorded.

The protection due to vaccination is evaluated by comparison of the survival in the vaccinated group and the survival in control group of mice at 72 hours from the challenge. Percentage of survival relative to controls is calculated using the formula:

$$\frac{\text{rate of survival in vaccine group - rate of survival in control group}}{\text{rate of survival in control group}}$$

Results

Immunization was carried out as above with positive controls IroN and IbeA. As can be seen in Figures 3 and 4 the % survival of the mice after challenge with IHE3034 is increased following immunization with either IroN or IbeA.

Immunization was then carried out with heat-inactivated IHE3034. As can be seen in Figure 1, the % survival of the mice after challenge with IHE3034 is increased following immunization with heat-inactivated IHE3034.

Immunization was also carried out with vesicles from IHE3034 ΔTol-R. As can be seen in Figure 2, the % survival of the mice after challenge with IHE3034 is increased following immunization with IHE3034 ΔTol-R.

Immunisation studies

Antigens are selected for combining to give a composition of the invention. BALB/c mice are divided into nine groups and immunized as follows:

Group	Immunizing Composition	Route of Delivery
1	Mixture of antigens (10-20 µg protein/each) + CFA (Complete Freund's Adjuvant)	Intra-peritoneal or intra-nasal or subcutaneous
2	Mixture of antigens (5 µg/each) +Al-hydroxide (200µg)	Intra-peritoneal or intra-nasal or subcutaneous
3	Mixture of antigens (10-20µg protein /each) +CpG (10ug)	Intra-peritoneal or intra-nasal or subcutaneous
4	Mixture of antigens (10-20µg protein /each) + Al-hydroxide (200µg) + CpG (10µg)	Intra-peritoneal or intra-nasal or subcutaneous
5	CFA	Intra-peritoneal or intra-nasal or subcutaneous
6	Mixture of antigens (10-20µg protein/each) +	Intra-peritoneal or Intranasal or

CT/US06/05913	LTK63 (5μg)	subcutaneous
7	Al-hydroxide (200μg) + CpG (10μg)	Intra-peritoneal or intra-nasal or subcutaneous
8	CpG (10μg)	Intra-peritoneal or intra-nasal or subcutaneous
9	LTK63 (5μg)	Intra-peritoneal or intra-nasal or subcutaneous

Mice are immunized at two-week intervals. Two to three weeks after the last immunization, all mice are challenged with the appropriate MNEC strain. When mucosal immunization (*e.g.* intranasal) is used, the animal model is also challenged mucosally to test the protective effect of the mucosal immunogen. Immediately prior to challenge, mice are bled to determine antibody titre to the antigens that were administered.

For the mouse challenge, virulent bacteria will be grown in appropriate media. Bacteria are harvested by centrifugation, re-suspended, and serially diluted for the challenge inoculum. BALB/c mice are challenged and observed daily for 30 days post-exposure.

Total IgG and IgG1/IgG2A subtypes can be measured in mouse sera resulting from the different immunization regimens by using an ELISA assay on whole bacteria and on purified recombinant proteins. Furthermore, assessment of antigen-specific CD4+ and CD8+Th-cells in spleen cells and/or PBMC isolated from immunized mice can be carried out by multi-parametric FACS analysis, to evaluate the cytokine expression profiles of antigen-specific T-cells. In particular production of IFN-γ and IL-5 can be measured after *in vitro* stimulation of T cells with purified antigens. In addition, splenocytes and/or PBMC from mice immunized with each antigen/vaccine formulation may be collected 10-12 days after the last immunization dose and stimulated with MNEC bacteria. After 4 hours of stimulation, Brefeldin A is added to the cells for the following 12 hours, to block cytokine secretion. Afterwards cells are fixed and stained with antibodies to detect MNEC-specific T cells expressing IFN-γ and IL-5.

T cells can be isolated from peripheral blood lymphocytes (PBLs) by a variety of procedures known to those skilled in the art. For example, T cell populations can be "enriched" from a population of PBLs through the removal of accessory and B cells. In particular, T cell enrichment can be accomplished by the elimination of non-T cells using anti-MHC class II monoclonal antibodies. Similarly, other antibodies can be used to deplete specific populations of non-T cells. For example, anti-Ig antibody molecules can be used to deplete B cells and anti-MacI antibody molecules can be used to deplete macrophages.

T cells can be further fractionated into a number of different subpopulations by techniques known to those skilled in the art. Two major subpopulations can be isolated based on their differential expression of the cell surface markers CD4 and CD8. For example, following the enrichment of T

cells as described above, CD4+ cells can be enriched using antibodies specific for CD4. The antibodies may be coupled to a solid support such as magnetic beads. Conversely, CD8+ cells can be enriched through the use of antibodies specific for CD4 (to remove CD4+ cells), or can be-isolated by the use of CD8 antibodies coupled to a solid support. CD4 lymphocytes from MNEC-infected patients can be expanded *ex vivo*, before or after transduction.

Following purification of T cells, the purified T cells are pre-stimulated with various cytokines including but not limited to rIL-2, IL-10, IL-12, and IL-15, which promote growth and activation of lymphocytes.

MNEC-specific T cells, may be activated by the above described immunogenic polypeptides. MNEC-specific T cells can be CD8+ or CD4+. MNEC-specific CD8+ T cells can be cytotoxic T lymphocytes (CTL) which can kill MNEC-infected cells that display any of the above described polypeptides or fragments thereof complexed with an MHC class I molecule. Chlamydia-specific CD8+ T cells can be detected by, for example, ^{51}Cr release assays. ^{51}Cr release assays measure the ability of MNEC-specific CD8+ T cells to lyse target cells displaying one or more of these epitopes. MNEC-specific CD8+ T cells which express antiviral agents, such as IFN γ, are also contemplated herein and can also be detected by immunological methods, preferably by intracellular staining for IFN-γ or alike cytokines after *in vitro* stimulation with one or more of the above described MNE polypeptides. MNEC-specific CD4+ T cells can be detected by a lymphoproliferation assay. Lymphoproliferation assays measure the ability of MNEC-specific CD4+ T cells to proliferate in response to one or more of the above described polypeptides.

It will be understood that the invention has been described by way of example only and modifications may be made whilst remaining within the scope and spirit of the invention.

TABLE 1 Annotation of ORF00001 to ORF04995

ORFnnnnn	SEQ ID NOs	Annotation
ORF00001	1 & 2	Phosphoglycerol transferase I
ORF00002	3 & 4	primosomal operon 17.5K protein (mdob-dnac intergenic region)
ORF00003	5 & 6	DNA replication protein dnaC
ORF00004	7 & 8	Primosomal protein I
ORF00005	9 & 10	probable integral membrane protein Cj1165c , putative
ORF00006	11 & 12	probable integral membrane protein Cj1166c , putative
ORF00007	13 & 14	transcriptional regulator, LuxR family domain protein
ORF00008	15 & 16	Transcriptional activator protein bglJ
ORF00009	17 & 18	Ferric iron reductase protein fhuF [1.6.99.-]
ORF00010	19 & 20	Protein of unknown function (DUF1435) family
ORF00011	21 & 22	conserved hypothetical protein
ORF00012	23 & 24	Ribosomal RNA small subunit methyltransferase C (AE005668) [2.1.1.52]
ORF00013	25 & 26	DNA polymerase III, psi subunit (holD) [2.7.7.7]
ORF00014	27 & 28	ribosomal-protein-alanine acetyltransferase (riml) [2.3.1.128]
ORF00015	29 & 30	HAD superfamily (subfamily IA) hydrolase, TIGR02254
ORF00016	31 & 32	site-specific recombinase, phage integrase family
ORF00017	33 & 34	hypothetical protein
ORF00018	35 & 36	conserved hypothetical protein
ORF00019	37 & 38	Hypothetical nin region protein (cysD)
ORF00020	39 & 40	hypothetical protein
ORF00021	41 & 42	conserved hypothetical protein
ORF00022	43 & 44	Sb36
ORF00023	45 & 46	Sb36
ORF00024	47 & 48	hypothetical protein
ORF00025	49 & 50	hypothetical protein
ORF00026	51 & 52	conserved hypothetical protein
ORF00027	53 & 54	repressor
ORF00028	55 & 56	Sb40
ORF00029	57 & 58	immunity region
ORF00030	59 & 60	conserved hypothetical protein
ORF00031	61 & 62	replication protein
ORF00032	63 & 64	hypothetical protein
ORF00033	65 & 66	phage N-6-adenine-methyltransferase [2.1.1.72]
ORF00034	67 & 68	LexA repressor
ORF00035	69 & 70	crossover junction endodeoxyribonuclease [3.1.22.-]
ORF00036	71 & 72	Sb46
ORF00037	73 & 74	Protein of unknown function (DUF1277) superfamily
ORF00038	75 & 76	Antitermination protein Q homolog from lambdoid prophage
ORF00039	77 & 78	lysis protein S.b1556
ORF00040	79 & 80	endolysin (lysozyme) [3.2.1.17]
ORF00041	81 & 82	Bacteriophage lysis protein
ORF00042	83 & 84	hypothetical protein
ORF00043	85 & 86	Gifsy-2 prophage protein
ORF00044	87 & 88	Phage terminase large subunit (GpA)
ORF00045	89 & 90	conserved hypothetical protein
ORF00046	91 & 92	phage portal protein, lambda family
ORF00047	93 & 94	Gifsy-2 prophage resembles Clp protease
ORF00048	95 & 96	conserved hypothetical protein
ORF00049	97 & 98	Gifsy-2 prophage ATP-binding sugar transporter-like protein

ORF00050	99 & 100	Gifsy-1 prophage: similar to minor tail protein Z
ORF00051	101 & 102	Phage minor tail protein U
ORF00052	103 & 104	putative tail component of prophage CP-933K
ORF00053	105 & 106	phage minor tail protein G
ORF00054	107 & 108	phage tail assembly protein T
ORF00055	109 & 110	Gifsy-1 prophage protein
ORF00056	111 & 112	Phage minor tail protein
ORF00057	113 & 114	phage minor tail protein L
ORF00058	115 & 116	Putative tail fiber component K of prophage
ORF00059	117 & 118	Putative tail fiber component K of prophage
ORF00060	119 & 120	Gifsy-1 prophage protein
ORF00061	121 & 122	Gifsy-1 prophage protein
ORF00062	123 & 124	host specificity protein (partial)
ORF00063	125 & 126	Lom
ORF00064	127 & 128	conserved hypothetical protein
ORF00065	129 & 130	hypothetical protein
ORF00066	131 & 132	conserved hypothetical protein
ORF00067	133 & 134	conserved hypothetical protein
ORF00068	135 & 136	conserved hypothetical protein
ORF00069	137 & 138	maturase-related protein
ORF00070	139 & 140	DinI-like protein Z3916-ECs3483 (AF175466)
ORF00071	141 & 142	peptide chain release factor 3 (prfC)
ORF00072	143 & 144	Osmotically inducible protein Y precursor
ORF00073	145 & 146	Protein of unknown function (DUF1328) family
ORF00074	147 & 148	unnamed protein product
ORF00075	149 & 150	Mg-dependent DNase
ORF00076	151 & 152	pyruvate formate lyase activating enzyme (act) [1.97.1.4]
ORF00077	153 & 154	Protein
ORF00078	155 & 156	conserved hypothetical protein
ORF00079	157 & 158	deoxyribose-phosphate aldolase (deoC) [4.1.2.4]
ORF00080	159 & 160	Thymidine phosphorylase (TDRPASE)
ORF00081	161 & 162	phosphopentomutase (deoB) [5.4.2.7]
ORF00082	163 & 164	purine nucleoside phosphorylase (deoD) [2.4.2.1]
ORF00083	165 & 166	conserved hypothetical protein
ORF00084	167 & 168	lipoate-protein ligase A [6.3.4.-]
ORF00085	169 & 170	Protein smp precursor
ORF00086	171 & 172	phosphoserine phosphatase (serB) [3.1.3.3]
ORF00087	173 & 174	DNA repair protein RadA (radA)
ORF00088	175 & 176	nicotinamide-nucleotide adenylyltransferase [2.7.7.1]
ORF00089	177 & 178	conserved hypothetical protein
ORF00090	179 & 180	Helix-turn-helix motif
ORF00091	181 & 182	ABC transporter ATP-binding protein yjjK (atp_bind)
ORF00092	183 & 184	soluble lytic murein transglycosylase [3.2.1.-]
ORF00093	185 & 186	trp operon repressor (trpR)
ORF00094	187 & 188	conserved hypothetical protein TIGR00258
ORF00095	189 & 190	phosphoglycerate mutase family protein, putative [5.4.2.1]
ORF00096	191 & 192	Right origin-binding protein
ORF00097	193 & 194	CreA protein
ORF00098	195 & 196	Transcriptional Regulatory protein creB
ORF00099	197 & 198	Sensor protein creC [2.7.3.-]
ORF00100	199 & 200	Inner membrane protein creD (AE005671)
ORF00101	201 & 202	Aerobic respiration control protein arcA (Dye resistance protein) (arcA)

ORF00102	203 & 204	RNA methyltransferase, TrmH family, group 1
ORF00103	205 & 206	aspartokinase I, homoserine dehydrogenase I
ORF00104	207 & 208	homoserine kinase (thrB) [2.7.1.39]
ORF00105	209 & 210	threonine synthase (thrC) [4.2.3.1]
ORF00106	211 & 212	unnamed protein product; ORF_ID:o101#5
ORF00107	213 & 214	conserved hypothetical protein
ORF00108	215 & 216	UPF0246 protein yaaA
ORF00109	217 & 218	unnamed protein product (ORF8)
ORF00110	219 & 220	transaldolase (tal) [2.2.1.2]
ORF00111	221 & 222	Molybdopterin biosynthesis mog protein
ORF00112	223 & 224	gpr1-fun34-yaaH family protein
ORF00113	225 & 226	unnamed protein product; ORF4
ORF00114	227 & 228	conserved hypothetical protein
ORF00115	229 & 230	hypothetical protein
ORF00116	231 & 232	chaperone protein DnaK (dnaK)
ORF00117	233 & 234	chaperone protein DnaJ (dnaJ)
ORF00118	235 & 236	gef protein-related protein
ORF00119	237 & 238	Putative conserved protein
ORF00120	239 & 240	Sulfatase, putative
ORF00121	241 & 242	conserved hypothetical protein
ORF00122	243 & 244	Na+-H+ antiporter NhaA (nhaA)
ORF00123	245 & 246	Transcriptional activator protein nhaR
ORF00124	247 & 248	riboflavin biosynthesis protein RibF (ribF) [2.7.1.26 2.7.7.2]
ORF00125	249 & 250	isoleucyl-tRNA synthetase (ileS) [6.1.1.5]
ORF00126	251 & 252	lipoprotein signal peptidase (lspA) [3.4.23.36]
ORF00127	253 & 254	5.2.1.8 [5.2.1.8]
ORF00128	255 & 256	4-hydroxy-3-methylbut-2-enyl diphosphate reductase (ispH) [1.17.1.2]
ORF00129	257 & 258	inosine-uridine preferring nucleoside hydrolase [3.2.-.-]
ORF00130	259 & 260	hyopthetical protein DUF805
ORF00131	261 & 262	dihydrodipicolinate reductase (dapB) [1.3.1.26]
ORF00132	263 & 264	carbamoyl-phosphate synthase, small subunit (carA) [6.3.5.5]
ORF00133	265 & 266	carbamoyl-phosphate synthase, large subunit (carB) [6.3.5.5]
ORF00134	267 & 268	Transposase
ORF00135	269 & 270	Transcriptional activatory protein caiF
ORF00136	271 & 272	Carnitine operon protein caiE
ORF00137	273 & 274	echA1 [5.-.-.-]
ORF00138	275 & 276	caiC (fadD) [6.3.2.-]
ORF00139	277 & 278	CAIB-BAIF family protein, putative [2.8.3.-]
ORF00140	279 & 280	Crotonobetainyl-CoA dehydrogenase (Crotonobetainyl-CoAreductase) (acd) [1.3.99.-]
ORF00141	281 & 282	L-carnitine-gamma-butyrobetaine antiporter
ORF00142	283 & 284	electron transfer flavoprotein, beta subunit, putative
ORF00143	285 & 286	electron transfer flavoprotein, alpha subunit, putative
ORF00144	287 & 288	FixC protein [1.5.5.-]
ORF00145	289 & 290	Ferredoxin-like protein
ORF00146	291 & 292	sugar transporter, putative
ORF00147	293 & 294	Glutathione-regulated potassium-efflux system ancillary protein kefF (QUINONE) [1.6.99.2]
ORF00148	295 & 296	Glutathione-regulated potassium-efflux system protein kefC (K(+)-H(+)antiporter)
ORF00149	297 & 298	dihydrofolate reductase (folA) [1.5.1.3]
ORF00150	299 & 300	CcdB antidote CcdA
ORF00151	301 & 302	CcdB-like protein

ORF00152	303 & 304	CdB like protein
ORF00153	305 & 306	bis(5'-nucleosyl)-tetraphosphatase (symmetrical) [3.6.1.41]
ORF00154	307 & 308	Protein apaG (AJ012295)
ORF00155	309 & 310	dimethyladenosine transferase (ksgA) [2.1.1.-]
ORF00156	311 & 312	4-hydroxythreonine-4-phosphate dehydrogenase (pdxA) [1.1.1.262]
ORF00157	313 & 314	Survival protein surA precursor (Peptidyl-prolyl cis-trans isomerasesurA) (PPIase) (Rotamase C) (PPIase) [5.2.1.8]
ORF00158	315 & 316	Organic solvent tolerance protein precursor
ORF00159	317 & 318	Organic solvent tolerance protein precursor
ORF00160	319 & 320	DnaJ-like protein djlA (AE005182)
ORF00161	321 & 322	ribosomal large subunit pseudouridine synthase A
ORF00162	323 & 324	RNA polymerase associated protein (hepA) [3.6.1.-]
ORF00163	325 & 326	hypothetical protein
ORF00164	327 & 328	DNA polymerase II
ORF00165	329 & 330	L-ribulose-5-phosphate 4-epimerase (araD) [5.1.3.4]
ORF00166	331 & 332	L-arabinose isomerase (araA) [5.3.1.4]
ORF00167	333 & 334	L-ribulokinase (araB) [2.7.1.16]
ORF00168	335 & 336	transcriptional regulator, AraC family
ORF00169	337 & 338	conserved hypothetical protein
ORF00170	339 & 340	DedA family integral membrane protein
ORF00171	341 & 342	thiamine ABC transporter, ATP-binding protein
ORF00172	343 & 344	thiamine-thiamine pyrophosphate ABC transporter, permease protein (thiP)
ORF00173	345 & 346	thiamin-thiamin pyrophosphate ABC transporter, thiamin-thiamin pyrophospate-binding protein (thiB)
ORF00174	347 & 348	Bacterial extracellular solute-binding proteins, family 5 family
ORF00175	349 & 350	3-isopropylmalate dehydratase, small subunit (leuD) [4.2.1.33]
ORF00176	351 & 352	3-isopropylmalate dehydratase, large subunit (leuC) [4.2.1.33]
ORF00177	353 & 354	3-isopropylmalate dehydrogenase (leuB) [1.1.1.85]
ORF00178	355 & 356	2-isopropylmalate synthase (leuA) [2.3.3.13]
ORF00179	357 & 358	LeuO protein.
ORF00180	359 & 360	acetolactate synthase, large subunit, biosynthetic type (ilvB) [2.2.1.6]
ORF00181	361 & 362	acetolactate synthase, small subunit (ilvN) [2.2.1.6]
ORF00182	363 & 364	transcriptional repressor of fru operon and others
ORF00183	365 & 366	mraZ protein (mraZ)
ORF00184	367 & 368	S-adenosyl-methyltransferase MraW (mraW) [2.1.1.-]
ORF00185	369 & 370	Cell division protein ftsL
ORF00186	371 & 372	Peptidoglycan synthetase ftsI precursor (PBP) [2.4.1.129]
ORF00187	373 & 374	UDP-N-acetylmuramoylalanyl-D-glutamate--2,6-diaminopimelate ligase
ORF00188	375 & 376	UDP-N-acetylmuramoylalanyl-D-glutamyl-2, 6-diaminopimelate--D-alanyl-D-alanyl ligase (murF) [6.3.2.10]
ORF00189	377 & 378	phospho-N-acetylmuramoyl-pentapeptide-transferase (mraY) [2.7.8.13]
ORF00190	379 & 380	UDP-N-acetylmuramoylalanine--D-glutamate ligase (murD) [6.3.2.9]
ORF00191	381 & 382	Cell division protein ftsW
ORF00192	383 & 384	undecaprenyldiphospho-muramoylpentapeptide beta-N-acetylglucosaminyltransferase (murG) [2.4.1.227]
ORF00193	385 & 386	UDP-N-acetylmuramate--alanine ligase (murC) [6.3.2.8]
ORF00194	387 & 388	D-alanine--D-alanine ligase B (ddlB) [6.3.2.4]
ORF00195	389 & 390	Acetolactate synthase isozyme III large subunit [4.1.3.18]
ORF00196	391 & 392	acetolactate synthase, small subunit (ilvN) [2.2.1.6]
ORF00197	393 & 394	fructose repressor (catabolite repressor-activator)
ORF00198	395 & 396	fructose repressor (catabolite repressor-activator)
ORF00199	397 & 398	Acetolactate synthase isozyme III large subunit [4.1.3.18]

ORF00200	399 & 400	acetolactate synthase, small subunit (ilvN) [2.2.1.6]
ORF00201	401 & 402	fructose repressor (catabolite repressor-activator)
ORF00202	403 & 404	D-alanine-D-alanine ligase B (ddlB) [6.3.2.4]
ORF00203	405 & 406	cell division protein ftsQ
ORF00204	407 & 408	cell division protein FtsA (ftsA)
ORF00205	409 & 410	Cell division protein ftsZ
ORF00206	411 & 412	UDP-3-0-acyl N-acetylglucosamine deacetylase (lpxC) [3.5.1.-]
ORF00207	413 & 414	Secretion monitor precursor
ORF00208	415 & 416	secA protein
ORF00209	417 & 418	preprotein translocase, SecA subunit (secA)
ORF00210	419 & 420	Mutator mutT protein (mutT) [3.6.1.-]
ORF00211	421 & 422	UPF0243 zinc-binding protein yacG-related protein
ORF00212	423 & 424	Hypothetical UPF0289 protein yacF
ORF00213	425 & 426	dephospho-CoA kinase (coaE) [2.7.1.24]
ORF00214	427 & 428	guanosine monophosphate reductase (guaC) [1.7.1.7]
ORF00215	429 & 430	Protein transport protein hofC (MTB)
ORF00216	431 & 432	Protein transport protein hofB (MTB)
ORF00217	433 & 434	Prepilin peptidase dependent protein D precursor
ORF00218	435 & 436	nicotinate-nucleotide pyrophosphorylase (nadC) [2.4.2.19]
ORF00219	437 & 438	AmpD protein (ampD)
ORF00220	439 & 440	regulates ampC
ORF00221	441 & 442	Aromatic amino acid transport protein aroP (General aromatic aminoacid permease)
ORF00222	443 & 444	uropathogenic specific protein
ORF00223	445 & 446	unnamed protein product; 9 bp deletion at the 3' end OrfU2
ORF00224	447 & 448	uropathogenic specific protein (partial) [3.1.-.-]
ORF00225	449 & 450	unnamed protein product; OrfU3
ORF00226	451 & 452	unnamed protein product; OrfU1
ORF00227	453 & 454	Pyruvate dehydrogenase complex repressor
ORF00228	455 & 456	Pyruvate dehydrogenase E1 component (aceE) [1.2.4.1]
ORF00229	457 & 458	pyruvate dehydrogenase complex dihydrolipoamide acetyltransferase (aceF) [2.3.1.12]
ORF00230	459 & 460	dihydrolipoamide dehydrogenase (lpdA) [1.8.1.4]
ORF00231	461 & 462	conserved hypothetical protein
ORF00232	463 & 464	hypothetical protein
ORF00233	465 & 466	hypothetical protein
ORF00234	467 & 468	aconitate hydratase 2 (acnB) [4.2.1.3]
ORF00235	469 & 470	S-adenosylmethionine decarboxylase proenzyme
ORF00236	471 & 472	spermidine synthase (speE) [2.5.1.16]
ORF00237	473 & 474	yacC
ORF00238	475 & 476	Blue copper oxidase cueO precursor
ORF00239	477 & 478	Glucose dehydrogenase
ORF00240	479 & 480	hypoxanthine phosphoribosyltransferase (hpt) [2.4.2.8]
ORF00241	481 & 482	Protein yadF [4.2.1.1]
ORF00242	483 & 484	ABC transporter ATP-binding protein
ORF00243	485 & 486	ABC transporter integral membrane protein STY0195 (membrane)
ORF00244	487 & 488	Fructose-specific phosphotransferase system component homolog. (PTS) [2.7.1.69]
ORF00245	489 & 490	Polysaccharide deacetylase domain protein
ORF00246	491 & 492	aspartate 1-decarboxylase (panD) [4.1.1.11]
ORF00247	493 & 494	transposase
ORF00248	495 & 496	pantoate--beta-alanine ligase (panC) [6.3.2.1]
ORF00249	497 & 498	3-methyl-2-oxobutanoate hydroxymethyltransferase (panB) [2.1.2.11]

ORF00250	499 & 500	Hypothetical fimbrial-like protein yadC precursor
ORF00251	501 & 502	Protein yadK
ORF00252	503 & 504	Fimbrial protein subfamily
ORF00253	505 & 506	hypothetical protein
ORF00254	507 & 508	Outer membrane usher protein htrE precursor
ORF00255	509 & 510	Chaperone protein ecpD precursor
ORF00256	511 & 512	pilin chaperone ecpD2
ORF00257	513 & 514	2-amino-4-hydroxy-6-hydroxymethyldihydropteridine pyrophosphokinase (folK) [2.7.6.3]
ORF00258	515 & 516	Poly(A) polymerase (PAP) (Plasmid copy number protein) (PAP) [2.7.7.19]
ORF00259	517 & 518	poly(A) polymerase (PAP)
ORF00260	519 & 520	glutamate-tRNA ligase homolog yadB
ORF00261	521 & 522	dnaK suppressor protein
ORF00262	523 & 524	sugar fermentation stimulation protein (sfsA)
ORF00263	525 & 526	2-5 RNA ligase
ORF00264	527 & 528	ATP-dependent helicase HrpB (hrpB)
ORF00265	529 & 530	peptidoglycan synthetase penicillin-binding protein 1B
ORF00266	531 & 532	penicillin-binding protein 1B (mrcB)
ORF00267	533 & 534	Ferrichrome-iron receptor precursor (Ferric hydroxamate uptake)(Ferric hydroxamate receptor)
ORF00268	535 & 536	Ferrichrome transport ATP-binding protein fhuC
ORF00269	537 & 538	Ferrichrome-binding periplasmic protein precursor
ORF00270	539 & 540	Ferrichrome transport system permease protein fhuB (membrane)
ORF00271	541 & 542	glutamate-1-semialdehyde-2,1-aminomutase (hemL) [5.4.3.8]
ORF00272	543 & 544	H(+)-Cl(-) exchange transporter clcA
ORF00273	545 & 546	HesB family protein
ORF00274	547 & 548	predicted membrane protein
ORF00275	549 & 550	Vitamin B12 transport protein btuF precursor (PBP)
ORF00276	551 & 552	MTA-SAH nucleosidase
ORF00277	553 & 554	deoxyguanosinetriphosphate triphosphohydrolase, putative subfamily [3.1.5.1]
ORF00278	555 & 556	htrA product [3.4.21.-]
ORF00279	557 & 558	Carbohydrate diacid regulator
ORF00280	559 & 560	Hypothetical UPF0325 protein yaeH
ORF00281	561 & 562	2,3,4,5-tetrahydropyridine-2,6-dicarboxylate N-succinyltransferase (dapD) [2.3.1.117]
ORF00282	563 & 564	protein-P-II uridylyltransferase (glnD) [2.7.7.59]
ORF00283	565 & 566	methionine aminopeptidase, type I (map) [3.4.11.18]
ORF00284	567 & 568	conserved hypothetical protein
ORF00285	569 & 570	30S ribosomal protein S2
ORF00286	571 & 572	translation elongation factor Ts (tsf)
ORF00287	573 & 574	uridylate kinase (pyrH) [2.7.4.-]
ORF00288	575 & 576	ribosome recycling factor (frr)
ORF00289	577 & 578	1-deoxy-D-xylulose 5-phosphate reductoisomerase (dxr) [1.1.1.267]
ORF00290	579 & 580	undecaprenyl diphosphate synthase (uppS) [2.5.1.31]
ORF00291	581 & 582	phosphatidate cytidylyltransferase (cdsA) [2.7.7.41]
ORF00292	583 & 584	membrane-associated zinc metalloprotease, putative
ORF00293	585 & 586	outer membrane protein precursor yaeT (D15)
ORF00294	587 & 588	histone-like protein, located in outer membrane or
ORF00295	589 & 590	UDP-3-O-[3-hydroxymyristoyl] glucosamine N-acyltransferase (lpxD) [2.3.1.-]
ORF00296	591 & 592	(3R)-hydroxymyristol acyl carrier protein dehydratase [4.2.1.-]
ORF00297	593 & 594	acyl-[acyl-carrier-protein]--UDP-N-acetylglucosamine O-acyltransferase (lpxA) [2.3.1.129]

ORF00298	595 & 596	lipid-A-disaccharide synthase (lpxB) [2.4.1.182]
ORF00299	597 & 598	ribonuclease HII (rnhB) [3.1.26.4]
ORF00300	599 & 600	DNA polymerase III alpha subunit (dnaE) [2.7.7.7]
ORF00301	601 & 602	acetyl-CoA carboxylase, carboxyl transferase, alpha subunit (accA) [6.4.1.2]
ORF00302	603 & 604	Lysine decarboxylase, constitutive (ldc) [4.1.1.18]
ORF00303	605 & 606	Lysine decarboxylase, constitutive (ldc) [4.1.1.18]
ORF00304	607 & 608	lactoylglutathione lyase
ORF00305	609 & 610	cell cycle protein (lle)
ORF00306	611 & 612	Rof protein
ORF00307	613 & 614	putative cytoplasmic protein
ORF00308	615 & 616	YaeQ protein
ORF00309	617 & 618	Peptidyl-tRNA hydrolase domain, putative
ORF00310	619 & 620	Copper homeostasis protein cutF precursor (lipoprotein)
ORF00311	621 & 622	yaeF protein
ORF00312	623 & 624	prolyl-tRNA synthetase (proS) [6.1.1.15]
ORF00313	625 & 626	UPF0066 protein rcsF (orf3)
ORF00314	627 & 628	Protein rcsF
ORF00315	629 & 630	D-methionine-binding lipoprotein metQ precursor (hlpA)
ORF00316	631 & 632	D-methionine transport system permease protein metI (membrane)
ORF00317	633 & 634	D-methionine ABC transporter, ATP-binding protein (metN)
ORF00318	635 & 636	unnamed protein product
ORF00319	637 & 638	hypothetical protein
ORF00320	639 & 640	2,5-diketo-D-gluconic acid reductase B (orf267) [1.1.1.274]
ORF00321	641 & 642	unnamed protein product; Highly similar to LysR-family transcriptional regulator, YafC protein of Escherichia coli (orf304)
ORF00322	643 & 644	unnamed protein product
ORF00323	645 & 646	methlytransferase, UbiE-COQ5 family
ORF00324	647 & 648	Membrane-bound lytic murein transglycosylase D precursor(Murein hydrolase D) (Regulatory protein dniR) [3.2.1.-]
ORF00325	649 & 650	hydroxyacylglutathione hydrolase [3.1.2.6]
ORF00326	651 & 652	hypothetical protein
ORF00327	653 & 654	conserved hypothetical protein
ORF00328	655 & 656	RNase HI, degrades RNA of DNA-RNA hybrids
ORF00329	657 & 658	DNA polymerase III, epsilon subunit (dnaQ) [2.7.7.7]
ORF00330	659 & 660	Hypothetical lipoprotein yafT precursor
ORF00331	661 & 662	Aec32
ORF00332	663 & 664	Aec31
ORF00333	665 & 666	Aec30
ORF00334	667 & 668	Aec29
ORF00335	669 & 670	hypothetical protein
ORF00336	671 & 672	Aec28
ORF00337	673 & 674	Aec27
ORF00338	675 & 676	Aec26
ORF00339	677 & 678	Aec25
ORF00340	679 & 680	Aec24
ORF00341	681 & 682	Aec23
ORF00342	683 & 684	hypothetical protein
ORF00343	685 & 686	Aec22
ORF00344	687 & 688	Aec20
ORF00345	689 & 690	Aec19
ORF00346	691 & 692	Aec18
ORF00347	693 & 694	Aec17

ORF00348	695 & 696	Aec16
ORF00349	697 & 698	Aec15 (AF044503)
ORF00350	699 & 700	Aec14
ORF00351	701 & 702	Aec13
ORF00352	703 & 704	Transposase (IS4 family)
ORF00353	705 & 706	Aec7
ORF00354	707 & 708	possible hydrolase
ORF00355	709 & 710	hypothetical protein
ORF00356	711 & 712	Inhibitor of vertebrate lysozyme precursor
ORF00357	713 & 714	Acyl-CoA dehydrogenase (EC 1.3.99.-). [1.3.99.-]
ORF00358	715 & 716	Phosphoheptose isomerase (gmhA) [5.-.-.-]
ORF00359	717 & 718	Bacterial protein of unknown function (DUF949) superfamily
ORF00360	719 & 720	Predicted glutamine amidotransferase
ORF00361	721 & 722	conserved hypothetical protein
ORF00362	723 & 724	Hypothetical lipoprotein yafL precursor
ORF00363	725 & 726	Protein of unknown function (DUF1568) domain protein
ORF00364	727 & 728	FhiA protein
ORF00365	729 & 730	MbhA protein
ORF00366	731 & 732	DNA polymerase IV (Pol IV) [2.7.7.7]
ORF00367	733 & 734	prevent-host-death family protein
ORF00368	735 & 736	unnamed protein product
ORF00369	737 & 738	Hypothetical acetyltransferase yafP [2.3.1.-]
ORF00370	739 & 740	uncharacterized conserved protein, RtcB-UPF0027 family CAC3383
ORF00371	741 & 742	Peptide chain release factor homolog (RF)
ORF00372	743 & 744	aminoacyl-histidine dipeptidase PepD
ORF00373	745 & 746	Xanthine-guanine phosphoribosyltransferase (XGPRT) [2.4.2.22]
ORF00374	747 & 748	Hydrolases of the alpha-beta superfamily
ORF00375	749 & 750	Curlin genes transcriptional activatory protein
ORF00376	751 & 752	Outer membrane pore protein E precursor
ORF00377	753 & 754	glutamate 5-kinase (proB) [2.7.2.11]
ORF00378	755 & 756	gamma-glutamyl phosphate reductase (proA) [1.2.1.41]
ORF00379	757 & 758	HTH-type transcriptional regulator prsX
ORF00380	759 & 760	Haemoglobin protease
ORF00381	761 & 762	InsA
ORF00382	763 & 764	InsB
ORF00383	765 & 766	conserved hypothetical protein
ORF00384	767 & 768	YagU
ORF00385	769 & 770	Uncharacterised protein family (UPF0153) superfamily
ORF00386	771 & 772	conserved hypothetical protein
ORF00387	773 & 774	conserved hypothetical protein
ORF00388	775 & 776	conserved hypothetical protein
ORF00389	777 & 778	conserved hypothetical protein
ORF00390	779 & 780	MatB precursor
ORF00391	781 & 782	transcriptional regulator, LuxR family domain protein
ORF00392	783 & 784	ribosomal protein L36 (rpmJ)
ORF00393	785 & 786	tail protein
ORF00394	787 & 788	Sb24
ORF00395	789 & 790	tail fiber assembly protein
ORF00396	791 & 792	T4-exclusion protein gpIBEGd
ORF00397	793 & 794	hypothetical protein
ORF00398	795 & 796	hypothetical protein
ORF00399	797 & 798	NADH-dependent flavin oxidoreductase, Oye family [1.-.-.-]

ORF00400	799 & 800	dienelactone hydrolase domain protein (AE000230)
ORF00401	801 & 802	transcription regulator, LysR family Atu5241
ORF00402	803 & 804	transcriptional regulator (LysR family)
ORF00403	805 & 806	oxidoreductase, aldo-keto reductase family
ORF00404	807 & 808	2,5-diketo-D-gluconic acid reductase A [1.1.1.-]
ORF00405	809 & 810	Putative adhesin
ORF00406	811 & 812	Hypothetical transcriptional regulator ykgA
ORF00407	813 & 814	2,5-diketo-D-gluconic acid reductase A
ORF00408	815 & 816	MC21
ORF00409	817 & 818	Protein of unknown function (DUF1471) superfamily
ORF00410	819 & 820	pyridine nucleotide-disulfide oxidoreductase [1.16.1.1]
ORF00411	821 & 822	Hypothetical transcriptional regulator ykgD
ORF00412	823 & 824	Cysteine-rich domain protein
ORF00413	825 & 826	iron-sulfur cluster binding protein
ORF00414	827 & 828	Uncharacterized ACR, YkgG family COG1556 family
ORF00415	829 & 830	hypothetical protein
ORF00416	831 & 832	outer membrane autotransporter barrel domain protein
ORF00417	833 & 834	conserved hypothetical protein
ORF00418	835 & 836	conserved hypothetical protein
ORF00419	837 & 838	Type 1 fimbriae Regulatory protein fimB
ORF00420	839 & 840	choline dehydrogenase (betA) [1.1.99.1]
ORF00421	841 & 842	betaine aldehyde dehydrogenase (betB) [1.2.1.8]
ORF00422	843 & 844	Regulatory protein betI (U73857)
ORF00423	845 & 846	High-affinity choline transport protein
ORF00424	847 & 848	EAL domain protein
ORF00425	849 & 850	allS
ORF00426	851 & 852	glutathione-regulated potassium-efflux system protein
ORF00427	853 & 854	ankyrin repeat domain protein
ORF00428	855 & 856	conserved hypothetical protein
ORF00429	857 & 858	YahF-FdrA-like protein
ORF00430	859 & 860	YahG-YlbE-like protein
ORF00431	861 & 862	Carbamate kinase-like protein yahI [2.7.2.2]
ORF00432	863 & 864	Cytosine deaminase
ORF00433	865 & 866	Protein of unknown function (DUF984) superfamily
ORF00434	867 & 868	ABC transporter, substrate binding protein [sugar] (AE005211)
ORF00435	869 & 870	ribose ABC transporter (ATP-binding protein)
ORF00436	871 & 872	ribose ABC transporter, permease protein, putative
ORF00437	873 & 874	ABC sugar transporter, permease subunit (permease)
ORF00438	875 & 876	oxidoreductase, zinc-binding [1.1.1.2]
ORF00439	877 & 878	RhtC-like transporter STY0397 (RhtC)
ORF00440	879 & 880	Protein of unknown function (DUF1471) superfamily
ORF00441	881 & 882	propionate catabolism operon regulatory protein PrpR (prpR)
ORF00442	883 & 884	hypothetical protein
ORF00443	885 & 886	regulator for prp operon
ORF00444	887 & 888	hypothetical protein
ORF00445	889 & 890	methylisocitrate lyase (prpB) [4.1.3.30]
ORF00446	891 & 892	2-methylcitrate synthase (Methylcitrate synthase)(Citrate synthase 2) [2.3.3.5]
ORF00447	893 & 894	2-methylcitrate dehydratase (prpD) [4.2.1.79]
ORF00448	895 & 896	propionate--CoA ligase (prpE) [6.2.1.17]
ORF00449	897 & 898	cytosine transporter, putative
ORF00450	899 & 900	Cytosine deaminase
ORF00451	901 & 902	Galactoside O-acetyltransferase [2.3.1.18]

ORF00452	903 & 904	Lactose permease (Lactose-proton symport)
ORF00453	905 & 906	Beta-galactosidase (lacZ) [3.2.1.23]
ORF00454	907 & 908	transcriptional regulator, lacI family domain protein, putative
ORF00455	909 & 910	Arac-family transcriptional regulator
ORF00456	911 & 912	nucleoprotein-polynucleotide-associated enzyme
ORF00457	913 & 914	carboxylesterase [3.1.1.1]
ORF00458	915 & 916	alcohol dehydrogenase [similarity] (adhC) [1.-.-.-]
ORF00459	917 & 918	putative alpha helix chain
ORF00460	919 & 920	conserved hypothetical protein
ORF00461	921 & 922	Sugar phosphate nucleotydyl transferase
ORF00462	923 & 924	glucosaminyltransferase
ORF00463	925 & 926	Putative conserved protein
ORF00464	927 & 928	taurine ABC transporter, periplasmic binding protein (tauA)
ORF00465	929 & 930	taurine ABC transporter, ATP-binding protein (cmpC)
ORF00466	931 & 932	Taurine transport system permease protein tauC
ORF00467	933 & 934	alpha-ketoglutarate-dependent taurine dioxygenase [1.-.-.-]
ORF00468	935 & 936	delta-aminolevulinic acid dehydratase (hemB) [4.2.1.24]
ORF00469	937 & 938	puative autotransporter-virulence factor STY0405 (partial)
ORF00470	939 & 940	conserved hypothetical protein
ORF00471	941 & 942	beta-lactamase
ORF00472	943 & 944	SbmA protein
ORF00473	945 & 946	lipoprotein, putative
ORF00474	947 & 948	conserved hypothetical protein
ORF00475	949 & 950	conserved hypothetical protein
ORF00476	951 & 952	D-alanine--D-alanine ligase A (D-alanylalanine synthetaseA) (D-Ala-D-Ala ligase A) [6.3.2.4]
ORF00477	953 & 954	conserved hypothetical protein
ORF00478	955 & 956	LD01705p
ORF00479	957 & 958	Alkaline phosphatase precursor
ORF00480	959 & 960	induced by phosphate starvation
ORF00481	961 & 962	AdrA protein (GGDEF)
ORF00482	963 & 964	pyrroline-5-carboxylate reductase (proC) [1.5.1.2]
ORF00483	965 & 966	YaiI-YqxD family protein family
ORF00484	967 & 968	shikimate kinase (aroK) [2.7.1.71]
ORF00485	969 & 970	conserved hypothetical protein
ORF00486	971 & 972	AroM protein
ORF00487	973 & 974	uncharacterized protein conserved in bacteria
ORF00488	975 & 976	conserved hypothetical protein
ORF00489	977 & 978	conserved hypothetical protein
ORF00490	979 & 980	Recombination associated protein rdgC
ORF00491	981 & 982	possible NAGC-like transcriptional regulator
ORF00492	983 & 984	major facilitator family transporter
ORF00493	985 & 986	Exonuclease sbcC (P-loop) [3.1.15.-]
ORF00494	987 & 988	exonuclease SbcD (SbcD) [3.1.-.-]
ORF00495	989 & 990	conserved hypothetical protein
ORF00496	991 & 992	phosphate regulon transcriptional regulatory protein PhoB (phoB)
ORF00497	993 & 994	Phosphate regulon sensor protein phoR
ORF00498	995 & 996	hypothetical protein
ORF00499	997 & 998	conserved hypothetical protein
ORF00500	999 & 1000	branched-chain amino acid transport system II carrier protein (brnQ)
ORF00501	1001 & 1002	Proline-specific permease proY

ORF00502	1003 & 1004	maltodextrin glucosidase [3.2.1.20]
ORF00503	1005 & 1006	Protein of unknown function, DUF479 superfamily
ORF00504	1007 & 1008	S-adenosylmethionine:tRNA ribosyltransferase-isomerase (queA) [5.-.-.-]
ORF00505	1009 & 1010	queuine tRNA-ribosyltransferase (tgt) [2.4.2.29]
ORF00506	1011 & 1012	preprotein translocase, YajC subunit, putative
ORF00507	1013 & 1014	Protein-export membrane protein secD
ORF00508	1015 & 1016	protein-export membrane protein secF
ORF00509	1017 & 1018	HNH endonuclease domain protein
ORF00510	1019 & 1020	Nucleoside-specific channel-forming protein tsx precursor
ORF00511	1021 & 1022	yajI protein
ORF00512	1023 & 1024	conserved hypothetical protein TIGR00244
ORF00513	1025 & 1026	riboflavin biosynthesis protein RibD (ribD) [3.5.4.26 1.1.1.193]
ORF00514	1027 & 1028	6,7-dimethyl-8-ribityllumazine synthase
ORF00515	1029 & 1030	transcription antitermination factor NusB (nusB)
ORF00516	1031 & 1032	thiamine-monophosphate kinase (thiL) [2.7.4.16]
ORF00517	1033 & 1034	Phosphatidylglycerophosphatase A
ORF00518	1035 & 1036	probable oxidoreductase yajO [1.-.-.-]
ORF00519	1037 & 1038	1-deoxy-D-xylulose-5-phosphate synthase (dxs) [2.2.1.7]
ORF00520	1039 & 1040	Geranyltranstransferase (Farnesyl-diphosphate synthase)(FPP synthase) (ispA) [2.5.1.10]
ORF00521	1041 & 1042	exodeoxyribonuclease VII, small subunit (xseB) [3.1.11.6]
ORF00522	1043 & 1044	hypothetical protein
ORF00523	1045 & 1046	Thiamine biosynthesis protein thiI (thiI)
ORF00524	1047 & 1048	4-methyl-5(B-hydroxyethyl)-thiazole monophosphate biosynthesis enzyme (ThiJ)
ORF00525	1049 & 1050	2-dehydropantoate 2-reductase (panE) [1.1.1.169]
ORF00526	1051 & 1052	Protein yajQ
ORF00527	1053 & 1054	Hypothetical transport protein yajR
ORF00528	1055 & 1056	protoheme IX farnesyltransferase (cyoE) [2.5.1.-]
ORF00529	1057 & 1058	cytochrome o ubiquinol oxidase C subunit [1.10.3.-]
ORF00530	1059 & 1060	Cytochrome c oxidase subunit III
ORF00531	1061 & 1062	Ubiquinol oxidase polypeptide I (Cytochrome o subunit 1)(Oxidase BO(3) subunit 1) (Cytochrome o ubiquinol oxidase subunit 1)(Ubiquinol oxidase chain A) [1.10.3.-]
ORF00532	1063 & 1064	Ubiquinol oxidase polypeptide II precursor (Cytochrome osubunit 2) (Oxidase BO(3) subunit 2) (Cytochrome o ubiquinol oxidasesubunit 2) (Ubiquinol oxidase chain B) [1.10.3.-]
ORF00533	1065 & 1066	beta-lactamase induction signal transducer AmpG
ORF00534	1067 & 1068	AmpG-signal transducer
ORF00535	1069 & 1070	putative polymerase-proteinase
ORF00536	1071 & 1072	BolA protein
ORF00537	1073 & 1074	conserved hypothetical protein
ORF00538	1075 & 1076	Trigger factor (TF) (tig)
ORF00539	1077 & 1078	conserved hypothetical protein
ORF00540	1079 & 1080	trigger factor (tig) [5.2.1.8]
ORF00541	1081 & 1082	ATP-dependent Clp protease, proteolytic subunit ClpP (clpP) [3.4.21.92]
ORF00542	1083 & 1084	ATP-dependent Clp protease, ATP-binding subunit ClpX (clpX)
ORF00543	1085 & 1086	ATP-dependent protease La (lon) [3.4.21.53]
ORF00544	1087 & 1088	DNA-binding protein HU-beta, NS1 (HU)
ORF00545	1089 & 1090	Peptidyl-prolyl cis-trans isomerase D (PPIase D)(Rotamase D) [5.2.1.8]
ORF00546	1091 & 1092	DNA uptake protein
ORF00547	1093 & 1094	Predicted thioesterase
ORF00548	1095 & 1096	exsB protein
ORF00549	1097 & 1098	conserved hypothetical protein

ORF00550	1099 & 1100	Cof protein
ORF00551	1101 & 1102	transcriptional regulator, AsnC family
ORF00552	1103 & 1104	Multidrug resistance-like ATP-binding protein mdlA (atp)
ORF00553	1105 & 1106	multidrug resistance-like ATP-binding protein Mdl
ORF00554	1107 & 1108	glutamine synthetase activity regulation protein
ORF00555	1109 & 1110	ammonium transporter (amt)
ORF00556	1111 & 1112	acyl-CoA thioesterase II (tesB) [3.1.2.-]
ORF00557	1113 & 1114	hypothetical protein
ORF00558	1115 & 1116	glycoprotein-polysaccharide metabolism
ORF00559	1117 & 1118	predicted methylated DNA-protein cysteine methyltransferase
ORF00560	1119 & 1120	Protein of unknown function (DUF1428) superfamily
ORF00561	1121 & 1122	EAL domain protein
ORF00562	1123 & 1124	conserved hypothetical protein
ORF00563	1125 & 1126	Maltose O-acetyltransferase [2.3.1.79]
ORF00564	1127 & 1128	hypothetical protein
ORF00565	1129 & 1130	Hha protein
ORF00566	1131 & 1132	YmoB
ORF00567	1133 & 1134	Acriflavine resistance protein B
ORF00568	1135 & 1136	Acriflavine resistance protein A precursor
ORF00569	1137 & 1138	HTH-type transcriptional regulator acrR (Potential acrAB operonrepressor) (acrEF)
ORF00570	1139 & 1140	Potassium efflux system kefA
ORF00571	1141 & 1142	conserved hypothetical protein
ORF00572	1143 & 1144	primosomal replication protein N
ORF00573	1145 & 1146	Protein of unknown function (DUF454) family
ORF00574	1147 & 1148	hypothetical protein
ORF00575	1149 & 1150	adenine phosphoribosyltransferase (apt) [2.4.2.7]
ORF00576	1151 & 1152	DNA polymerase III, subunits gamma and tau, programmed (dnaX) [2.7.7.7]
ORF00577	1153 & 1154	conserved hypothetical protein TIGR00103
ORF00578	1155 & 1156	recombination protein RecR (recR)
ORF00579	1157 & 1158	Chaperone protein htpG (Heat shock protein htpG) (High temperatureprotein G) (Heat shock protein C62.5) (htpG)
ORF00580	1159 & 1160	Adenylate kinase
ORF00581	1161 & 1162	ferrochelatase (hemH) [4.99.1.1]
ORF00582	1163 & 1164	Acetyl esterase [3.1.1.-]
ORF00583	1165 & 1166	Inosine-guanosine kinase [2.7.1.73]
ORF00584	1167 & 1168	RosB
ORF00585	1169 & 1170	fosmidomycin resistance protein (CAMPs)
ORF00586	1171 & 1172	Protein ushA precursor [Includes: UDP-sugar hydrolase(UDP-sugar diphosphatase) (UDP-sugar pyrophosphatase); 5'-nucleotidase(EC 3.1.3.5) (5'-NT)] (5-NT) [3.6.1.45]
ORF00587	1173 & 1174	hypothetical protein
ORF00588	1175 & 1176	hypothetical protein
ORF00589	1177 & 1178	ybaK-ebsC protein (ybaK)
ORF00590	1179 & 1180	GumN protein superfamily
ORF00591	1181 & 1182	probable killer protein VCA0391
ORF00592	1183 & 1184	unnamed protein product; Some similarities with virulence associated protein A (vapA)
ORF00593	1185 & 1186	Copper-transporting P-type ATPase [3.6.1.-]
ORF00594	1187 & 1188	K-3-type glutaminase [3.5.1.2]
ORF00595	1189 & 1190	amino acid permease family protein, putative
ORF00596	1191 & 1192	Cu(I)-responsive transcriptional regulator (cueR)
ORF00597	1193 & 1194	hypothetical protein

ORF00598	1195 & 1196	lipoprotein, putative
ORF00599	1197 & 1198	adhesin-invasin-like protein
ORF00600	1199 & 1200	conserved hypothetical protein
ORF00601	1201 & 1202	membrane protein
ORF00602	1203 & 1204	band 7-Mec-2 family protein
ORF00603	1205 & 1206	ABC transporter, ATP-binding protein
ORF00604	1207 & 1208	membrane protein, putative
ORF00605	1209 & 1210	ybbN protein
ORF00606	1211 & 1212	oxidoreductase, short-chain dehydrogenase-reductase family (SDR) [1.-.-.-]
ORF00607	1213 & 1214	acyl-coA thioesterase I precursor [3.1.2.-]
ORF00608	1215 & 1216	ABC transporter, ATP-binding protein
ORF00609	1217 & 1218	permease, putative domain protein
ORF00610	1219 & 1220	YbbB
ORF00611	1221 & 1222	allS
ORF00612	1223 & 1224	Ureidoglycolate hydrolase (allA) [3.5.3.19]
ORF00613	1225 & 1226	Negative regulator of allantoin and glyoxylate utilization operons(Transcriptional regulator allR)
ORF00614	1227 & 1228	glyoxylate carboligase (gcl) [4.1.1.47]
ORF00615	1229 & 1230	Hydroxypyruvate isomerase [5.3.1.22]
ORF00616	1231 & 1232	2-hydroxy-3-oxopropionate reductase [1.1.1.60]
ORF00617	1233 & 1234	cytosine-purine-uracil-thiamine-allantoin permease family protein, putative
ORF00618	1235 & 1236	Allantoinase [3.5.2.5]
ORF00619	1237 & 1238	Putative purine permease ybbY
ORF00620	1239 & 1240	Glycerate kinase 1
ORF00621	1241 & 1242	GlxB6
ORF00622	1243 & 1244	Allantoate amidohydrolase (partial)
ORF00623	1245 & 1246	Ureidoglycolate dehydrogenase [1.1.1.154]
ORF00624	1247 & 1248	Protein fdrA
ORF00625	1249 & 1250	conserved hypothetical protein
ORF00626	1251 & 1252	Protein of unknown function (DUF1116) superfamily
ORF00627	1253 & 1254	conserved hypothetical protein
ORF00628	1255 & 1256	carbamate kinase (arcC) [2.7.2.2]
ORF00629	1257 & 1258	phosphoribosylaminoimidazole carboxylase, ATPase subunit (purK) [4.1.1.21]
ORF00630	1259 & 1260	phosphoribosylaminoimidazole carboxylase, catalytic subunit (purE) [4.1.1.21]
ORF00631	1261 & 1262	conserved hypothetical protein
ORF00632	1263 & 1264	UDP-2,3-diacylglucosamine hydrolase (lpxH) [3.6.1.-]
ORF00633	1265 & 1266	peptidyl-prolyl cis-trans isomerase B (ppiB) [5.2.1.8]
ORF00634	1267 & 1268	cysteinyl-tRNA synthetase (cysS) [6.1.1.16]
ORF00635	1269 & 1270	Predicted membrane-bound metal-dependent hydrolase (DUF457) family
ORF00636	1271 & 1272	Uncharacterized ACR-related protein
ORF00637	1273 & 1274	5,10-methylene-tetrahydrofolate dehydrogenase (folD) [1.5.1.5]
ORF00638	1275 & 1276	Prophage DLP12 integrase (Prophage QSR' integrase)
ORF00639	1277 & 1278	conserved hypothetical protein
ORF00640	1279 & 1280	Gp37
ORF00641	1281 & 1282	conserved hypothetical protein
ORF00642	1283 & 1284	Sb36
ORF00643	1285 & 1286	conserved hypothetical protein
ORF00644	1287 & 1288	unknown protein encoded by prophage CP-933N
ORF00645	1289 & 1290	antitermination protein Q
ORF00646	1291 & 1292	unknown protein encoded by prophage CP-933O
ORF00647	1293 & 1294	DNA adenine-methylase

ORF00648	1295 & 1296	lysis protein
ORF00649	1297 & 1298	conserved hypothetical protein
ORF00650	1299 & 1300	Protein of unknown function (DUF1327) superfamily
ORF00651	1301 & 1302	Lysozyme (Lysis protein) (Muramidase) (Endolysin) [3.2.1.17]
ORF00652	1303 & 1304	lipoprotein Rz1 precursor -related protein
ORF00653	1305 & 1306	Bacteriophage lysis protein
ORF00654	1307 & 1308	Bor protein homolog from lambdoid prophage DLP12
ORF00655	1309 & 1310	hypothetical protein
ORF00656	1311 & 1312	Partial tonB-like membrane protein encoded within prophage
ORF00657	1313 & 1314	conserved hypothetical protein
ORF00658	1315 & 1316	Terminase small subunit (DNA packaging protein NU1) (fragment)
ORF00659	1317 & 1318	Phage terminase large subunit (GpA)
ORF00660	1319 & 1320	gpW
ORF00661	1321 & 1322	phage portal protein, lambda family
ORF00662	1323 & 1324	head-tail preconnector protein GP5
ORF00663	1325 & 1326	Bacteriophage lambda head decoration protein D
ORF00664	1327 & 1328	Phage major capsid protein E
ORF00665	1329 & 1330	DNA packaging protein FI
ORF00666	1331 & 1332	Phage Head-Tail Attachment
ORF00667	1333 & 1334	Prophage minor tail protein Z (GPZ)
ORF00668	1335 & 1336	Phage minor tail protein U
ORF00669	1337 & 1338	Major tail protein V
ORF00670	1339 & 1340	phage minor tail protein G
ORF00671	1341 & 1342	minor tail protein
ORF00672	1343 & 1344	tail length tape measure protein precursor
ORF00673	1345 & 1346	phage tail tape measure protein, lambda family
ORF00674	1347 & 1348	phage minor tail protein L
ORF00675	1349 & 1350	Putative tail fiber component K of prophage
ORF00676	1351 & 1352	Bacteriophage lambda tail assembly protein I
ORF00677	1353 & 1354	host specificity protein (partial)
ORF00678	1355 & 1356	host specificity protein (partial)
ORF00679	1357 & 1358	Lom
ORF00680	1359 & 1360	conserved hypothetical protein
ORF00681	1361 & 1362	conserved hypothetical protein
ORF00682	1363 & 1364	conserved hypothetical protein
ORF00683	1365 & 1366	conserved hypothetical protein
ORF00684	1367 & 1368	Tail fiber assembly protein homolog from lambdoid prophage
ORF00685	1369 & 1370	proteinase, putative
ORF00686	1371 & 1372	Protease VII precursor (Omptin) (Outer membrane protein3B) (Protease A) (SopA) [3.4.21.87]
ORF00687	1373 & 1374	Prophage DLP12 integrase (Prophage QSR' integrase)
ORF00688	1375 & 1376	Tail fiber assembly protein homolog from lambdoid
ORF00689	1377 & 1378	Protease VII precursor (Omptin) (Outer membrane protein3B) (Protease A) (SopA) [3.4.21.87]
ORF00690	1379 & 1380	conserved hypothetical protein
ORF00691	1381 & 1382	Bacteriophage N4 adsorption protein A precursor
ORF00692	1383 & 1384	bacteriophage N4 adsorption protein NfrB
ORF00693	1385 & 1386	hypothetical protein
ORF00694	1387 & 1388	Sensor kinase cusS [2.7.3.-]
ORF00695	1389 & 1390	Transcriptional regulatory protein cusR
ORF00696	1391 & 1392	Cation efflux system protein cusC precursor
ORF00697	1393 & 1394	Cation efflux system protein cusF precursor

ORF00698	1395 & 1396	Cation efflux system protein cusB precursor
ORF00699	1397 & 1398	Cation efflux system protein cusA (CzcA)
ORF00700	1399 & 1400	Phenylalanine-specific permease
ORF00701	1401 & 1402	putative transport
ORF00702	1403 & 1404	Oxygen-insensitive NAD(P)H nitroreductase [1.-.-.-]
ORF00703	1405 & 1406	Uncharacterized protein conserved in bacteria
ORF00704	1407 & 1408	Protein of unknown function (DUF1158) superfamily
ORF00705	1409 & 1410	Glutamate-cysteine ligase family 2, putative
ORF00706	1411 & 1412	4-phosphopantetheinyl transferase entD
ORF00707	1413 & 1414	ferrienterobactin receptor precursor
ORF00708	1415 & 1416	conserved hypothetical protein
ORF00709	1417 & 1418	Enterochelin esterase
ORF00710	1419 & 1420	mbtH protein-related protein
ORF00711	1421 & 1422	enterobactin synthetase component F [2.7.7.-]
ORF00712	1423 & 1424	Ferric enterobactin transport protein fepE (enterochelin)
ORF00713	1425 & 1426	ferric exochelin uptake (fxuB)
ORF00714	1427 & 1428	ferric exochelin uptake (fxuA)
ORF00715	1429 & 1430	ferric exochelin uptake (fxuC)
ORF00716	1431 & 1432	membrane protein, putative
ORF00717	1433 & 1434	ferric enterobactin (enterochelin) binding protein; periplasmic component
ORF00718	1435 & 1436	isochorismate synthase [5.4.99.6]
ORF00719	1437 & 1438	2,3-dihydroxybenzoate-AMP ligase [2.7.7.58]
ORF00720	1439 & 1440	Isochorismatase (Isochorismate lyase) (2,3 dihydro-2,3dihydroxybenzoate synthase) (Enterobactin synthetase component B)(Enterochelin synthase B) (EntB) [3.3.2.1]
ORF00721	1441 & 1442	oxidoreductase, short-chain dehydrogenase-reductase family [1.3.1.28]
ORF00722	1443 & 1444	Hypothetical UPF0152 protein ybdB (p15)
ORF00723	1445 & 1446	Carbon starvation protein A
ORF00724	1447 & 1448	Uncharacterized small protein
ORF00725	1449 & 1450	glycerol dehydrogenase [1.1.-.-]
ORF00726	1451 & 1452	aminotransferase, class I [2.6.1.-]
ORF00727	1453 & 1454	unnamed protein product; ORF_ID:o166#4
ORF00728	1455 & 1456	conserved hypothetical protein
ORF00729	1457 & 1458	Hypothetical transcriptional regulator ybdO (orf2)
ORF00730	1459 & 1460	Thiol:disulfide interchange protein dsbG precursor
ORF00731	1461 & 1462	alkyl hydroperoxide reductase c22 protein [1.6.4.-]
ORF00732	1463 & 1464	alkyl hydroperoxide reductase F52A protein [1.6.4.-]
ORF00733	1465 & 1466	Universal stress protein G
ORF00734	1467 & 1468	Regulator of nucleoside diphosphate kinase
ORF00735	1469 & 1470	Ribonuclease I precursor [3.1.27.6]
ORF00736	1471 & 1472	Citrate carrier-transporter (antiport)
ORF00737	1473 & 1474	triphosphoribosyl-dephospho-CoA synthase (citG) [2.7.8.25]
ORF00738	1475 & 1476	Apo-citrate lyase phosphoribosyl-dephospho-CoA transferase (citX) [2.7.7.-]
ORF00739	1477 & 1478	citrate lyase, alpha subunit (citF) [2.8.3.10]
ORF00740	1479 & 1480	citrate lyase, beta subunit (citE) [4.1.3.6]
ORF00741	1481 & 1482	citrate lyase acyl carrier protein (citD)
ORF00742	1483 & 1484	citrate lyase ligase (citC) [6.2.1.22]
ORF00743	1485 & 1486	Sensor kinase dpiB
ORF00744	1487 & 1488	Transcriptional regulatory protein dpiA (Destabilizer of plasmidinheritance)
ORF00745	1489 & 1490	transport of dicarboxylates
ORF00746	1491 & 1492	CrcA protein
ORF00747	1493 & 1494	Cold shock-like protein cspE

ORF00748	1495 & 1496	crcB protein (crcB)
ORF00749	1497 & 1498	nitrilase
ORF00750	1499 & 1500	Sec-independent protein translocase protein tatA (YIGT)
ORF00751	1501 & 1502	lipoic acid synthetase (lipA)
ORF00752	1503 & 1504	lipoate-protein ligase B (lipB)
ORF00753	1505 & 1506	UPF0250 protein
ORF00754	1507 & 1508	penicillin-binding protein 5 (PBP) [3.4.16.4]
ORF00755	1509 & 1510	Rare lipoprotein A precursor (rlpA)
ORF00756	1511 & 1512	conserved hypothetical protein
ORF00757	1513 & 1514	rod shape-determining protein RodA (rodA)
ORF00758	1515 & 1516	Penicillin-binding protein 2 (PBP-2) (PBP)
ORF00759	1517 & 1518	Penicillin-binding protein 2 (PBP-2) (PBP)
ORF00760	1519 & 1520	conserved hypothetical protein TIGR00246
ORF00761	1521 & 1522	unnamed protein product
ORF00762	1523 & 1524	phosphoglycerate mutase family protein, putative [3.1.3.73]
ORF00763	1525 & 1526	nicotinate (nicotinamide) nucleotide adenylyltransferase (nadD) [2.7.7.18]
ORF00764	1527 & 1528	DNA polymerase III, delta subunit (holA) [2.7.7.7]
ORF00765	1529 & 1530	a minor lipoprotein
ORF00766	1531 & 1532	leucyl-tRNA synthetase (leuS) [6.1.1.4]
ORF00767	1533 & 1534	Methyl-accepting chemotaxis protein
ORF00768	1535 & 1536	Inosine-uridine nucleoside N-ribohydrolase (AL355920)
ORF00769	1537 & 1538	Glutamate-aspartate transport ATP-binding protein gltL
ORF00770	1539 & 1540	Glutamate-aspartate transport system permease protein gltK (membrane)
ORF00771	1541 & 1542	Glutamate-aspartate transport system permease protein gltJ
ORF00772	1543 & 1544	glutamate-aspartate ABC transporter, periplasmic glutamate-aspartate-binding protein, truncation
ORF00773	1545 & 1546	Rhomboid family family
ORF00774	1547 & 1548	Apolipoprotein N-acyltransferase (ALP N-acyltransferase)(Copper homeostasis protein cutE) [2.3.1.-]
ORF00775	1549 & 1550	Magnesium and cobalt efflux protein corC (tlyC)
ORF00776	1551 & 1552	predicted metal-dependent hydrolase
ORF00777	1553 & 1554	PhoH-like protein
ORF00778	1555 & 1556	tRNA-i(6)A37 thiotransferase enzyme MiaB (miaB)
ORF00779	1557 & 1558	2-octaprenyl-3-methyl-6-methoxy-1,4-benzoquinol hydroxylase
ORF00780	1559 & 1560	Asparagine synthetase B [glutamine-hydrolyzing]
ORF00781	1561 & 1562	nagD protein, degenerate
ORF00782	1563 & 1564	N-acetylglucosamine repressor
ORF00783	1565 & 1566	N-acetylglucosamine-6-phosphate deacetylase (nagA) [3.5.1.25]
ORF00784	1567 & 1568	glucosamine-6-phosphate isomerase (nagB) [3.5.99.6]
ORF00785	1569 & 1570	PTS system, N-acetylglucosamine-specific IIABC component (EII-Nag) [2.7.1.69]
ORF00786	1571 & 1572	membrane protein, putative
ORF00787	1573 & 1574	hypothetical protein
ORF00788	1575 & 1576	Hypthetical protein
ORF00789	1577 & 1578	Hypthetical protein
ORF00790	1579 & 1580	TerC protein
ORF00791	1581 & 1582	TerC protein
ORF00792	1583 & 1584	dihydrodipicolinate synthase (AE004999) [4.2.1.52]
ORF00793	1585 & 1586	Putative alcohol dehydrogenase (U59485)
ORF00794	1587 & 1588	Putative inner membrane protein
ORF00795	1589 & 1590	4-hydroxythreonine-4-phosphate dehydrogenase (pdxA) [1.1.1.262]
ORF00796	1591 & 1592	Transcriptional regulator of sugar metabolism, putative
ORF00797	1593 & 1594	glutaminyl-tRNA synthetase (glnS) [6.1.1.18]

ORF00798	1595 & 1596	Hypothetical protein
ORF00799	1597 & 1598	unnamed protein product; ORF_ID:o172#6
ORF00800	1599 & 1600	Hypothetical lipoprotein ybfN precursor
ORF00801	1601 & 1602	Ferric uptake regulation protein (Ferric uptake regulator)
ORF00802	1603 & 1604	Flavodoxin 1
ORF00803	1605 & 1606	urea amidolyase-related protein
ORF00804	1607 & 1608	urea amidolyase-related protein
ORF00805	1609 & 1610	SeqA protein
ORF00806	1611 & 1612	phosphoglucomutase, alpha-D-glucose phosphate-specific (pgm) [5.4.2.2]
ORF00807	1613 & 1614	Putrescine-ornithine antiporter (Putrescine transport protein) (potE)
ORF00808	1615 & 1616	Ornithine decarboxylase, inducible (speF) [4.1.1.17]
ORF00809	1617 & 1618	conserved hypothetical protein
ORF00810	1619 & 1620	hypothetical protein
ORF00811	1621 & 1622	kdpE
ORF00812	1623 & 1624	sensor histidine kinase KdpD, putative
ORF00813	1625 & 1626	K+-transporting ATPase, C subunit (kdpC) [3.6.3.12]
ORF00814	1627 & 1628	K+-transporting ATPase, B subunit (kdpB) [3.6.3.12]
ORF00815	1629 & 1630	K+-transporting ATPase, A subunit (kdpA) [3.6.3.12]
ORF00816	1631 & 1632	K+-transporting ATPase, F subunit (kdpF) [3.6.3.12]
ORF00817	1633 & 1634	conserved hypothetical protein
ORF00818	1635 & 1636	uncharacterized conserved protein (orf169)
ORF00819	1637 & 1638	Deoxyribodipyrimidine photolyase [4.1.99.3]
ORF00820	1639 & 1640	PTR2-family transport protein STY0750
ORF00821	1641 & 1642	conserved hypothetical protein TIGR00486
ORF00822	1643 & 1644	conserved hypothetical protein TIGR00370
ORF00823	1645 & 1646	urea amidolyase-related protein
ORF00824	1647 & 1648	LamB-YcsF family protein (lamB)
ORF00825	1649 & 1650	formamidopyrimidine-DNA glycosylase, putative [3.2.-.-]
ORF00826	1651 & 1652	membrane protein, putative
ORF00827	1653 & 1654	ybgO protein
ORF00828	1655 & 1656	citrate synthase I (gltA) [2.3.3.1]
ORF00829	1657 & 1658	succinate dehydrogenase cytochrome b-556 subunit (AF007569)
ORF00830	1659 & 1660	Succinate dehydrogenase hydrophobic membrane anchor protein (sdhD) [1.3.99.1]
ORF00831	1661 & 1662	succinate dehydrogenase, flavoprotein subunit (sdhA)
ORF00832	1663 & 1664	succinate dehydrogenase, iron sulfur protein [1.3.99.1]
ORF00833	1665 & 1666	2-oxoglutarate dehydrogenase, E1 component (sucA) [1.2.4.2]
ORF00834	1667 & 1668	2-oxoglutarate dehydrogenase, E2 component, dihydrolipoamide succinyltransferase (sucB) [2.3.1.61]
ORF00835	1669 & 1670	Dihydrolipoamide succinyltransferase component of 2-oxoglutarate dehydrogenase complex [2.3.1.61]
ORF00836	1671 & 1672	Succinyl-CoA synthetase beta chain (SCS-beta) (sucC) [6.2.1.5]
ORF00837	1673 & 1674	succinyl-CoA synthetase, alpha subunit (sucD) [6.2.1.5]
ORF00838	1675 & 1676	uncharacterized protein, probably surface-located
ORF00839	1677 & 1678	hypothetical protein
ORF00840	1679 & 1680	cytochrome d ubiquinol oxidase chain I [similarity] [1.10.3.-]
ORF00841	1681 & 1682	cytochrome d ubiquinol oxidase, subunit II (cydB) [1.10.3.-]
ORF00842	1683 & 1684	cyd operon protein YbgT-related protein
ORF00843	1685 & 1686	cyd operon protein YbgE
ORF00844	1687 & 1688	Predicted thioesterase
ORF00845	1689 & 1690	TolQ protein
ORF00846	1691 & 1692	TolR protein (tolR)
ORF00847	1693 & 1694	TolA protein

ORF00848	1695 & 1696	TolA protein
ORF00849	1697 & 1698	tolB (tolB)
ORF00850	1699 & 1700	Peptidoglycan-associated lipoprotein precursor
ORF00851	1701 & 1702	YbgF protein
ORF00852	1703 & 1704	quinolinate synthetase complex, A subunit (nadA)
ORF00853	1705 & 1706	Protein pnuC
ORF00854	1707 & 1708	cation efflux family protein (efflux)
ORF00855	1709 & 1710	conserved hypothetical protein
ORF00856	1711 & 1712	phospho-2-dehydro-3-deoxyheptonate aldolase [2.5.1.54]
ORF00857	1713 & 1714	hypothetical protein
ORF00858	1715 & 1716	Phosphoglycerate mutase 1
ORF00859	1717 & 1718	Aldose 1-epimerase
ORF00860	1719 & 1720	galactokinase (galK) [2.7.1.6]
ORF00861	1721 & 1722	galactose-1-phosphate uridylyltransferase (galT) [2.7.7.10]
ORF00862	1723 & 1724	UDP-glucose 4-epimerase (galE) [5.1.3.2]
ORF00863	1725 & 1726	ATP-binding component of molybdate transport system (atp_bind)
ORF00864	1727 & 1728	hypothetical protein
ORF00865	1729 & 1730	Transcriptional regulator modE (modE)
ORF00866	1731 & 1732	conserved hypothetical protein
ORF00867	1733 & 1734	molybdate ABC transporter, periplasmic molybdate-binding protein (modA)
ORF00868	1735 & 1736	molybdate ABC transporter, permease protein (modB)
ORF00869	1737 & 1738	molybdate ABC transporter, ATP-binding protein (modC) [3.6.3.29]
ORF00870	1739 & 1740	putative phosphatase
ORF00871	1741 & 1742	conserved hypothetical protein
ORF00872	1743 & 1744	ybhD protein
ORF00873	1745 & 1746	FldA protein
ORF00874	1747 & 1748	2-oxoglutarate-malate translocator homolog yflS (SODiT1)
ORF00875	1749 & 1750	aconitate hydratase, putative
ORF00876	1751 & 1752	possible pectinesterase precursor
ORF00877	1753 & 1754	conserved hypothetical protein TIGR00481
ORF00878	1755 & 1756	adenosylmethionine-8-amino-7-oxononanoate aminotransferase (bioA) [2.6.1.62]
ORF00879	1757 & 1758	biotin synthase (bioB) [2.8.1.6]
ORF00880	1759 & 1760	8-amino-7-oxononanoate synthase (bioF) [2.3.1.47]
ORF00881	1761 & 1762	biotin biosynthesis protein BioC (bioC)
ORF00882	1763 & 1764	Dethiobiotin synthetase (DTBS)
ORF00883	1765 & 1766	Phage minor tail protein
ORF00884	1767 & 1768	phage minor tail protein L
ORF00885	1769 & 1770	Putative tail fiber component K of prophage
ORF00886	1771 & 1772	Minor tail protein precursor H
ORF00887	1773 & 1774	Phage minor tail protein
ORF00888	1775 & 1776	phage minor tail protein L
ORF00889	1777 & 1778	Putative tail component of prophage
ORF00890	1779 & 1780	Phage minor tail protein L
ORF00891	1781 & 1782	Putative tail component of prophage
ORF00892	1783 & 1784	Phage minor tail protein L
ORF00893	1785 & 1786	Putative tail fiber component K of prophage
ORF00894	1787 & 1788	Putative tail fiber component K of prophage
ORF00895	1789 & 1790	Bacteriophage lambda tail assembly protein I
ORF00896	1791 & 1792	host specificity protein (partial)
ORF00897	1793 & 1794	tail assembly protein
ORF00898	1795 & 1796	Bacteriophage lambda tail assembly protein I
ORF00899	1797 & 1798	host specificity protein (partial)

ORF00900	1799 & 1800	Putative tail component of prophage (partial)
ORF00901	1801 & 1802	hypothetical protein
ORF00902	1803 & 1804	conserved hypothetical protein
ORF00903	1805 & 1806	conserved hypothetical protein
ORF00904	1807 & 1808	conserved hypothetical protein
ORF00905	1809 & 1810	SitD protein (AF128999)
ORF00906	1811 & 1812	SitC protein (AF128999)
ORF00907	1813 & 1814	SitB protein (AF128999)
ORF00908	1815 & 1816	periplasmic binding protein (chelated)
ORF00909	1817 & 1818	putative transposase
ORF00910	1819 & 1820	conserved hypothetical protein
ORF00911	1821 & 1822	isocitrate dehydrogenase [1.1.1.42]
ORF00912	1823 & 1824	ydfO protein
ORF00913	1825 & 1826	Hypothetical transcriptional regulator ycgE
ORF00914	1827 & 1828	conserved hypothetical protein
ORF00915	1829 & 1830	Sensors of blue-light using FAD family
ORF00916	1831 & 1832	probable membrane protein b1168 (o528)
ORF00917	1833 & 1834	conserved hypothetical protein
ORF00918	1835 & 1836	conserved hypothetical protein
ORF00919	1837 & 1838	conserved hypothetical protein
ORF00920	1839 & 1840	conserved hypothetical protein
ORF00921	1841 & 1842	putative ATP-binding component of a transport system
ORF00922	1843 & 1844	cell division topological specificity factor MinE (minE)
ORF00923	1845 & 1846	cell division inhibitor MinD
ORF00924	1847 & 1848	tail assembly protein
ORF00925	1849 & 1850	Host specificity protein J (partial)
ORF00926	1851 & 1852	host specificity protein (partial)
ORF00927	1853 & 1854	excinuclease ABC, B subunit (uvrB)
ORF00928	1855 & 1856	Uncharacterized conserved membrane-associated protein
ORF00929	1857 & 1858	Molybdenum cofactor biosynthesis protein A
ORF00930	1859 & 1860	molybdenum cofactor biosynthesis protein B
ORF00931	1861 & 1862	molybdenum cofactor biosynthesis protein C (moaC)
ORF00932	1863 & 1864	Molybdopterin converting factor subunit 1 (MPT)
ORF00933	1865 & 1866	Molybdopterin converting factor subunit 2
ORF00934	1867 & 1868	conserved hypothetical protein
ORF00935	1869 & 1870	membrane protein (SAD)
ORF00936	1871 & 1872	hypothetical protein
ORF00937	1873 & 1874	Uncharacterized protein family UPF0005, putative
ORF00938	1875 & 1876	membrane protein, putative
ORF00939	1877 & 1878	phospholipase family protein [2.7.8.-]
ORF00940	1879 & 1880	endonuclease-exonuclease-phosphatase family protein
ORF00941	1881 & 1882	ABC transporter, permease protein, putative
ORF00942	1883 & 1884	conserved hypothetical protein
ORF00943	1885 & 1886	ElsD (membrane)
ORF00944	1887 & 1888	ABC transporter, ATP binding-permease protein
ORF00945	1889 & 1890	Hypothetical membrane protein ybhG
ORF00946	1891 & 1892	probable transcription regulator ybiH
ORF00947	1893 & 1894	Superfamily II DNA and RNA helicases
ORF00948	1895 & 1896	GTP cyclohydrolase II (F160)
ORF00949	1897 & 1898	probably ATP-dependent helicase
ORF00950	1899 & 1900	glycosyl transferase family protein (o320) [2.4.2.18]
ORF00951	1901 & 1902	YbiC (o361) [1.1.1.-]

ORF00952	1903 & 1904	Protein of unknown function (DUF1471) superfamily
ORF00953	1905 & 1906	TraR
ORF00954	1907 & 1908	iron-regulated outer membrane protein
ORF00955	1909 & 1910	TonB-dependent receptor for iron transport XF0599 (III)
ORF00956	1911 & 1912	hypothetical protein
ORF00957	1913 & 1914	Protein of unknown function (DUF1471) family
ORF00958	1915 & 1916	Protein of unknown function (DUF890) superfamily
ORF00959	1917 & 1918	putative transport protein
ORF00960	1919 & 1920	ATP-binding component of glutamine high-affinity transport system (atp_bind)
ORF00961	1921 & 1922	amino acid ABC transporter, amino acid-binding-permease protein
ORF00962	1923 & 1924	amino acid ABC transporter, amino acid-binding-permease protein (GlnH)
ORF00963	1925 & 1926	global regulator, starvation conditions
ORF00964	1927 & 1928	transporter, EamA family
ORF00965	1929 & 1930	outer membrane protein X
ORF00966	1931 & 1932	Dca
ORF00967	1933 & 1934	Transcriptional regulator mntR (Manganese transport regulator)
ORF00968	1935 & 1936	transporter, NadC-P-Pho87 family, putative
ORF00969	1937 & 1938	Protein ybiS precursor
ORF00970	1939 & 1940	ABC transporter ATP-binding protein
ORF00971	1941 & 1942	hydrolase, haloacid dehalogenase-like family
ORF00972	1943 & 1944	pyruvate formate-lyase [2.3.1.54]
ORF00973	1945 & 1946	Iron-dependent pyruvate formate-lyase-activating enzyme (pflC) [1.97.1.4]
ORF00974	1947 & 1948	transaldolase, putative
ORF00975	1949 & 1950	molybdopterin synthase sulfurylase MoeB (moeB)
ORF00976	1951 & 1952	Molybdopterin biosynthesis protein moeA (moeA)
ORF00977	1953 & 1954	asparaginase [3.5.1.1]
ORF00978	1955 & 1956	Hypothetical ABC transporter ATP-binding protein in bcr 5'region. (D90720)
ORF00979	1957 & 1958	Heme-binding protein a precursor (hemin-binding lipoprotein).
ORF00980	1959 & 1960	ABC transporter permease protein (permease)
ORF00981	1961 & 1962	peptide ABC transporter, permease protein
ORF00982	1963 & 1964	EAL domain protein
ORF00983	1965 & 1966	Hypothetical membrane protein yliF
ORF00984	1967 & 1968	MiaB-like tRNA modifying enzyme YliG, TIGR01125
ORF00985	1969 & 1970	conserved hypothetical protein
ORF00986	1971 & 1972	lppZ
ORF00987	1973 & 1974	glutathione S-transferase
ORF00988	1975 & 1976	Penicillin-binding protein 6 precursor (PBP) [3.4.16.4]
ORF00989	1977 & 1978	Deoxyribose operon repressor (AE006172)
ORF00990	1979 & 1980	unnamed protein product
ORF00991	1981 & 1982	hypothetical protein
ORF00992	1983 & 1984	Multidrug translocase mdfA
ORF00993	1985 & 1986	conserved hypothetical protein
ORF00994	1987 & 1988	hydrolase, haloacid dehalogenase-like family
ORF00995	1989 & 1990	Major Facilitator Superfamily subfamily
ORF00996	1991 & 1992	transcription regulator, TetR family , putative
ORF00997	1993 & 1994	TrkA, Potassium channel-family protein
ORF00998	1995 & 1996	conserved hypothetical protein
ORF00999	1997 & 1998	Glutaredoxin, GrxA family (grxA)
ORF01000	1999 & 2000	Protein of unknown function (DUF1418) superfamily
ORF01001	2001 & 2002	Oxygen-insensitive NADPH nitroreductase [1.-.-.-]
ORF01002	2003 & 2004	ribosomal protein S6 modification protein
ORF01003	2005 & 2006	putative sensory transduction regulator

ORF01004	2007 & 2008	Putrescine-binding periplasmic protein precursor
ORF01005	2009 & 2010	Putrescine transport ATP-binding protein potG (atp_bind)
ORF01006	2011 & 2012	putrescine ABC transporter, permease protein (membrane)
ORF01007	2013 & 2014	Putrescine transport system permease protein potI
ORF01008	2015 & 2016	conserved hypothetical protein
ORF01009	2017 & 2018	23S rRNA (uracil-5-)-methyltransferase RumB (rumB) [2.1.1.-]
ORF01010	2019 & 2020	Arginine-binding periplasmic protein 2 precursor
ORF01011	2021 & 2022	Arginine transport system permease protein artM (membrane)
ORF01012	2023 & 2024	Arginine transport system permease protein artQ (artQ)
ORF01013	2025 & 2026	Arginine-binding periplasmic protein 1 precursor
ORF01014	2027 & 2028	Arginine transport ATP-binding protein artP
ORF01015	2029 & 2030	Putative lipoprotein ybjP precursor
ORF01016	2031 & 2032	conserved protein
ORF01017	2033 & 2034	N-acetylmuramoyl-L-alanine amidase domain protein [3.5.1.28]
ORF01018	2035 & 2036	conserved hypothetical protein
ORF01019	2037 & 2038	COG0702:Predicted nucleoside-diphosphate-sugar epimerases, putative
ORF01020	2039 & 2040	Low-specificity L-threonine aldolase [4.1.2.5]
ORF01021	2041 & 2042	pyruvate dehydrogenase [1.2.2.2]
ORF01022	2043 & 2044	iron-sulfur cluster-binding protein
ORF01023	2045 & 2046	hybrid cluster protein
ORF01024	2047 & 2048	putative surface protein
ORF01025	2049 & 2050	aquaporin Z
ORF01026	2051 & 2052	homology with RecF protein
ORF01027	2053 & 2054	SomA (VirG)
ORF01028	2055 & 2056	Macrolide-specific efflux protein macA precursor
ORF01029	2057 & 2058	Macrolide-specific ABC-type efflux carrier (efflux)
ORF01030	2059 & 2060	Cold shock-like protein cspD
ORF01031	2061 & 2062	site-specific recombinase, phage integrase family, truncation
ORF01032	2063 & 2064	probable DNA binding protein -related protein
ORF01033	2065 & 2066	hypothetical protein
ORF01034	2067 & 2068	conserved hypothetical protein
ORF01035	2069 & 2070	conserved hypothetical protein
ORF01036	2071 & 2072	hypothetical bacteriophage protein
ORF01037	2073 & 2074	Bacteriophage P4 DNA primase
ORF01038	2075 & 2076	Unknown protein encoded by prophage
ORF01039	2077 & 2078	Single-strand binding protein (SSB) (Helix-destabilizing protein) (ssb)
ORF01040	2079 & 2080	hypothetical protein
ORF01041	2081 & 2082	conserved hypothetical protein
ORF01042	2083 & 2084	Gifsy-1 prophage protein
ORF01043	2085 & 2086	Head decoration protein (Head protein GPSHP)
ORF01044	2087 & 2088	hypothetical protein
ORF01045	2089 & 2090	head-tail preconnector protein GP5
ORF01046	2091 & 2092	gp1
ORF01047	2093 & 2094	Unknown protein encoded by prophage
ORF01048	2095 & 2096	Unknown protein encoded by prophage
ORF01049	2097 & 2098	ATP-dependent Clp protease adaptor protein clpS
ORF01050	2099 & 2100	ATP-binding component of serine protease
ORF01051	2101 & 2102	ATP-dependent clp protease ATP-binding subunit clpA
ORF01052	2103 & 2104	CRISPR-associated protein Cas1 (cas1)
ORF01053	2105 & 2106	unnamed protein product; Similar to unknown protein
ORF01054	2107 & 2108	conserved hypothetical protein
ORF01055	2109 & 2110	conserved hypothetical protein

ORF01056	2111 & 2112	conserved hypothetical protein
ORF01057	2113 & 2114	conserved hypothetical protein
ORF01058	2115 & 2116	conserved hypothetical protein
ORF01059	2117 & 2118	translation initiation factor IF-1 (infA)
ORF01060	2119 & 2120	leucyl-phenylalanyl-tRNA--protein transferase (aat) [2.3.2.-]
ORF01061	2121 & 2122	Transport ATP-binding protein cydC
ORF01062	2123 & 2124	Transport ATP-binding protein cydD
ORF01063	2125 & 2126	Antirestriction protein family
ORF01064	2127 & 2128	YeeS protein (o160)
ORF01065	2129 & 2130	Transport ATP-binding protein cydD
ORF01066	2131 & 2132	thioredoxin-disulfide reductase (trxB) [1.8.1.9]
ORF01067	2133 & 2134	Leucine-responsive Regulatory protein
ORF01068	2135 & 2136	Cell division protein ftsK
ORF01069	2137 & 2138	outer membrane lipoprotein carrier protein LolA (lolA)
ORF01070	2139 & 2140	unnamed protein product
ORF01071	2141 & 2142	seryl-tRNA synthetase (serS) [6.1.1.11]
ORF01072	2143 & 2144	Anaerobic dimethyl sulfoxide reductase chain A precursor (dmsA) [1.8.99.-]
ORF01073	2145 & 2146	anaerobic dimethylsulfoxide reductase chain B (dmsB) [1.-.-.-]
ORF01074	2147 & 2148	DMSO reductase anchor subunit (DmsC) (dmsC) [1.8.99.-]
ORF01075	2149 & 2150	Protein ycaC
ORF01076	2151 & 2152	Hypothetical MFS-type transporter protein ycaD
ORF01077	2153 & 2154	pyruvate formate lyase activating enzyme 1 [1.97.1.4]
ORF01078	2155 & 2156	phage integrase
ORF01079	2157 & 2158	phage regulatory protein
ORF01080	2159 & 2160	gpB
ORF01081	2161 & 2162	gp80-related protein
ORF01082	2163 & 2164	InsAB' protein
ORF01083	2165 & 2166	InsA protein
ORF01084	2167 & 2168	gp81
ORF01085	2169 & 2170	TraR protein
ORF01086	2171 & 2172	gp83
ORF01087	2173 & 2174	Replication gene A protein (GPA)
ORF01088	2175 & 2176	gp91
ORF01089	2177 & 2178	conserved hypothetical protein
ORF01090	2179 & 2180	hypothetical protein
ORF01091	2181 & 2182	hypothetical protein
ORF01092	2183 & 2184	phage portal protein, PBSX family
ORF01093	2185 & 2186	Putative ATPase subunit of terminase (gpP-like)
ORF01094	2187 & 2188	Phage capsid scaffolding protein (GPO)
ORF01095	2189 & 2190	capsid scaffolding protein
ORF01096	2191 & 2192	phage major capsid protein, P2 family
ORF01097	2193 & 2194	Phage small terminase subunit
ORF01098	2195 & 2196	Phage head completion protein (GPL)
ORF01099	2197 & 2198	Tail protein X (GPX)-related protein
ORF01100	2199 & 2200	Phage holin family 2
ORF01101	2201 & 2202	Lysozyme (Lysis protein) (Muramidase) (Endolysin)(Protein gpK) [3.2.1.17]
ORF01102	2203 & 2204	hypothetical protein
ORF01103	2205 & 2206	Protein lysA
ORF01104	2207 & 2208	Protein lysB (AB008550)
ORF01105	2209 & 2210	LysC
ORF01106	2211 & 2212	Tail completion protein R (GPR)
ORF01107	2213 & 2214	phage virion morphogenesis protein

ORF01108	2215 & 2216	gpV (gpV)
ORF01109	2217 & 2218	Baseplate assembly protein W (GPW) (gpW)
ORF01110	2219 & 2220	Baseplate J-like protein
ORF01111	2221 & 2222	gpI (gpI)
ORF01112	2223 & 2224	gpH
ORF01113	2225 & 2226	gpG (gpG)
ORF01114	2227 & 2228	hypothetical protein
ORF01115	2229 & 2230	Phage tail sheath protein
ORF01116	2231 & 2232	phage major tail tube protein
ORF01117	2233 & 2234	Phage tail protein E
ORF01118	2235 & 2236	phage tail tape meausure protein, TP901 family, putative
ORF01119	2237 & 2238	gpU (gpU)
ORF01120	2239 & 2240	Gene D protein (GPD)
ORF01121	2241 & 2242	Ogr
ORF01122	2243 & 2244	formate acetyltransferase (pflB) [2.3.1.54]
ORF01123	2245 & 2246	Probable formate transporter 1
ORF01124	2247 & 2248	unnamed protein product
ORF01125	2249 & 2250	Protein of unknown function (DUF421) family
ORF01126	2251 & 2252	phosphoserine aminotransferase (serC) [2.6.1.52]
ORF01127	2253 & 2254	3-phosphoshikimate 1-carboxyvinyltransferase (aroA) [2.5.1.19]
ORF01128	2255 & 2256	cmk protein precursor [3.4.24.-]
ORF01129	2257 & 2258	cytidylate kinase (cmk) [2.7.4.14]
ORF01130	2259 & 2260	ribosomal protein S1 (rpsA)
ORF01131	2261 & 2262	integration host factor, beta subunit (ihfB)
ORF01132	2263 & 2264	DNA internalization-related competence protein ComEC-Rec2
ORF01133	2265 & 2266	lipid A export ATP-binding-permease protein MsbA (msbA)
ORF01134	2267 & 2268	tetraacyldisaccharide 4'-kinase (lpxK) [2.7.1.130]
ORF01135	2269 & 2270	Protein of unknown function (DUF1006) superfamily
ORF01136	2271 & 2272	Tetraacyldisaccharide-1-P 4'-kinase
ORF01137	2273 & 2274	3-deoxy-D-manno-octulosonate cytidylyltransferase (kdsB) [2.7.7.38]
ORF01138	2275 & 2276	Uncharacterized ACR, COG1434 family
ORF01139	2277 & 2278	mukF protein (killing factor KicB)
ORF01140	2279 & 2280	conserved hypothetical protein
ORF01141	2281 & 2282	Protein smtA
ORF01142	2283 & 2284	Chromosome partition protein mukF (kicB)
ORF01143	2285 & 2286	Chromosome partition protein mukE
ORF01144	2287 & 2288	cell division protein mukB (mukB)
ORF01145	2289 & 2290	conserved hypothetical protein
ORF01146	2291 & 2292	Bacterial protein of unknown function (DUF882) superfamily
ORF01147	2293 & 2294	metallo-beta-lactamase superfamily protein [3.-.-.-]
ORF01148	2295 & 2296	Aspartate aminotransferase (aspC) [2.6.1.1]
ORF01149	2297 & 2298	Outer membrane protein F precursor (GBP)
ORF01150	2299 & 2300	asparaginyl-tRNA synthetase (asnS) [6.1.1.22]
ORF01151	2301 & 2302	nicotinate phosphoribosyltransferase (pncB) [2.4.2.11]
ORF01152	2303 & 2304	aminopeptidase N (pepN) [3.4.11.2]
ORF01153	2305 & 2306	sulfonate ABC transporter, ATP-binding subunit SsuB (AF075709)
ORF01154	2307 & 2308	sulfonate ABC transporter, permease protein SsuC
ORF01155	2309 & 2310	Alkanesulfonate monooxygenase [1.14.14.5]
ORF01156	2311 & 2312	hypothetical protein
ORF01157	2313 & 2314	ABC transporter, aliphatic sulfonates binding protein
ORF01158	2315 & 2316	FMN reductase [1.5.1.29]

ORF01159	2317 & 2318	dihydroorotate oxidase (pyrD) [1.3.3.1]
ORF01160	2319 & 2320	Protein of unknown function (DUF1379) superfamily
ORF01161	2321 & 2322	flavodoxin reductase (ferredoxin-NADPH reductase) family 1
ORF01162	2323 & 2324	predicted N6-adenine-specific DNA methylase
ORF01163	2325 & 2326	ABC transporter ATP-binding protein uup
ORF01164	2327 & 2328	hypothetical protein
ORF01165	2329 & 2330	Paraquat-inducible protein A
ORF01166	2331 & 2332	paraquat-inducible protein B
ORF01167	2333 & 2334	Protein of unknown function (DUF330) superfamily
ORF01168	2335 & 2336	Ribosome modulation factor (Protein E)-related protein
ORF01169	2337 & 2338	beta-hydroxyacyl-(acyl-carrier-protein) dehydratase FabA (fabA) [4.2.1.-]
ORF01170	2339 & 2340	unnamed protein product
ORF01171	2341 & 2342	Outer membrane protein A precursor
ORF01172	2343 & 2344	Cell division inhibitor
ORF01173	2345 & 2346	hypothetical membrane protein, TIGR01666 (yccS)
ORF01174	2347 & 2348	Regulator of competence-specific genes
ORF01175	2349 & 2350	Domain of unknown function
ORF01176	2351 & 2352	DNA helicase IV [3.6.1.-]
ORF01177	2353 & 2354	methylglyoxal synthase (mgsA) [4.2.3.3]
ORF01178	2355 & 2356	Hypothetical UPF0319 protein yccT precursor
ORF01179	2357 & 2358	Protein yccU
ORF01180	2359 & 2360	hemimethylated DNA binding domain, putative
ORF01181	2361 & 2362	predicted SAM-dependent methyltransferase
ORF01182	2363 & 2364	Acylphosphatase
ORF01183	2365 & 2366	probable sulfite reductase gamma chain [1.8.-.-]
ORF01184	2367 & 2368	Integral membrane protein
ORF01185	2369 & 2370	Hydrogenase-1 small chain precursor
ORF01186	2371 & 2372	conserved hypothetical protein
ORF01187	2373 & 2374	Unknown protein encoded within prophage
ORF01188	2375 & 2376	Uncharacterized BCR, COG1636 family
ORF01189	2377 & 2378	putative cell killing protein of prophage (gef)
ORF01190	2379 & 2380	Protein of unknown function (DUF1277) superfamily
ORF01191	2381 & 2382	endodeoxyribonuclease RUS (Holliday junction resolvase) [3.1.22.-]
ORF01192	2383 & 2384	Antitermination protein Q homolog of cryptic prophage
ORF01193	2385 & 2386	hypothetical protein
ORF01194	2387 & 2388	unnamed protein product; ORF137, length
ORF01195	2389 & 2390	lysis protein S.b1556
ORF01196	2391 & 2392	hypothetical bacteriophage protein
ORF01197	2393 & 2394	Lysozyme (Lysis protein) (Muramidase) (Endolysin) [3.2.1.17]
ORF01198	2395 & 2396	lipoprotein Rz1 precursor -related protein
ORF01199	2397 & 2398	Bacteriophage lysis protein
ORF01200	2399 & 2400	Sb56
ORF01201	2401 & 2402	phage terminase, small subunit, putative, P27 family, putative
ORF01202	2403 & 2404	phage terminase, large subunit, putative
ORF01203	2405 & 2406	hypothetical protein
ORF01204	2407 & 2408	phage portal protein, HK97 family
ORF01205	2409 & 2410	Caudovirus prohead protease
ORF01206	2411 & 2412	phage major capsid protein, HK97 family
ORF01207	2413 & 2414	uncharacterized phage protein (possible DNA packaging)
ORF01208	2415 & 2416	phage head-tail adaptor, putative
ORF01209	2417 & 2418	phage protein, HK97 gp10 family

ORF01210	2419 & 2420	Gp11
ORF01211	2421 & 2422	major tail subunit
ORF01212	2423 & 2424	Phage tail assembly chaperone
ORF01213	2425 & 2426	Gp14
ORF01214	2427 & 2428	tail length tape measure protein
ORF01215	2429 & 2430	phage minor tail protein L
ORF01216	2431 & 2432	Putative tail fiber component K of prophage
ORF01217	2433 & 2434	Bacteriophage lambda tail assembly protein I
ORF01218	2435 & 2436	Host specificity protein J (partial)
ORF01219	2437 & 2438	Host specificity protein J (partial)
ORF01220	2439 & 2440	host specificity protein (partial)
ORF01221	2441 & 2442	Lom
ORF01222	2443 & 2444	conserved hypothetical protein
ORF01223	2445 & 2446	conserved hypothetical protein
ORF01224	2447 & 2448	conserved hypothetical protein
ORF01225	2449 & 2450	conserved hypothetical protein
ORF01226	2451 & 2452	CdtA
ORF01227	2453 & 2454	CdtB
ORF01228	2455 & 2456	CdtC
ORF01229	2457 & 2458	Periplasmic solute binding protein family family
ORF01230	2459 & 2460	MEMBRANE PROTEIN
ORF01231	2461 & 2462	Hypothetical UPF0190 protein yedY (AE005419)
ORF01232	2463 & 2464	transthyretin family protein
ORF01233	2465 & 2466	Transcriptional activator protein CopR.
ORF01234	2467 & 2468	histidine kinase [2.7.3.-]
ORF01235	2469 & 2470	H-NS-repressed protein, 30K (Hsp31)
ORF01236	2471 & 2472	Outer membrane protein N precursor (OmpF)
ORF01237	2473 & 2474	HD domain protein
ORF01238	2475 & 2476	DNA-cytosine methyltransferase (M.EcoDcm) [2.1.1.37]
ORF01239	2477 & 2478	integral membrane protein
ORF01240	2479 & 2480	patch repair protein [3.1.-.-]
ORF01241	2481 & 2482	Protein of unknown function
ORF01242	2483 & 2484	conserved hypothetical protein
ORF01243	2485 & 2486	conserved hypothetical protein
ORF01244	2487 & 2488	diguanylate cyclase (GGDEF) domain protein
ORF01245	2489 & 2490	mannosyl-3-phosphoglycerate phosphatase-related protein [3.1.3.-]
ORF01246	2491 & 2492	conserved hypothetical protein
ORF01247	2493 & 2494	conserved hypothetical protein
ORF01248	2495 & 2496	Colanic acid capsular biosynthesis activation protein A
ORF01249	2497 & 2498	flagellar biosynthetic protein FliR (fliR)
ORF01250	2499 & 2500	flagellar biosynthetic protein FliQ (fliQ)
ORF01251	2501 & 2502	flagellar biosynthetic protein FliP (fliP)
ORF01252	2503 & 2504	terminase large subunit
ORF01253	2505 & 2506	phage terminase family protein, putative
ORF01254	2507 & 2508	hypothetical protein
ORF01255	2509 & 2510	Gp45
ORF01256	2511 & 2512	conserved hypothetical protein
ORF01257	2513 & 2514	CI protein
ORF01258	2515 & 2516	transcriptional regulator, Cro-CI family-related protein
ORF01259	2517 & 2518	repressor (cII)
ORF01260	2519 & 2520	O (DNA replication;299)
ORF01261	2521 & 2522	P protein

ORF01262	2523 & 2524	hydrogenase
ORF01263	2525 & 2526	Hydrogenase-1 large chain (NiFe hydrogenase) (Membrane-bound hydrogenase 1 large subunit) (HYD1) (hyaB) [1.12.99.6]
ORF01264	2527 & 2528	Ni-Fe-hydrogenase, b-type cytochrome subunit (CybH)
ORF01265	2529 & 2530	Hydrogenase 1 maturation protease [3.4.24.-]
ORF01266	2531 & 2532	Hydrogenase-1 operon protein hyaE
ORF01267	2533 & 2534	Hydrogenase-1 operon protein hyaF
ORF01268	2535 & 2536	cytochrome d ubiquinol oxidase, subunit I
ORF01269	2537 & 2538	cytochrome d ubiquinol oxidase, subunit II (cydB) [1.10.3.-]
ORF01270	2539 & 2540	conserved hypothetical protein
ORF01271	2541 & 2542	cold shock-like protein
ORF01272	2543 & 2544	Periplasmic appA protein precursor (agp) [3.1.3.2]
ORF01273	2545 & 2546	hypothetical protein
ORF01274	2547 & 2548	cold shock-like protein
ORF01275	2549 & 2550	GnsB protein
ORF01276	2551 & 2552	Putative electron transport protein yccM
ORF01277	2553 & 2554	2.7.3.- [2.7.3.-]
ORF01278	2555 & 2556	TorCAD operon transcriptional Regulatory protein torR
ORF01279	2557 & 2558	Periplasmic protein torT precursor
ORF01280	2559 & 2560	trimethylamine-N-oxide reductase c-type cytochrome TorC (torC)
ORF01281	2561 & 2562	trimethylamine-N-oxide reductase TorA (torA) [1.7.2.3]
ORF01282	2563 & 2564	Chaperone protein torD
ORF01283	2565 & 2566	conserved hypothetical protein
ORF01284	2567 & 2568	conserved hypothetical protein
ORF01285	2569 & 2570	dnaJ protein
ORF01286	2571 & 2572	periplasmic glucose-1-phosphatase
ORF01287	2573 & 2574	conserved hypothetical protein
ORF01288	2575 & 2576	trp repressor-binding protein
ORF01289	2577 & 2578	conserved hypothetical protein
ORF01290	2579 & 2580	uracil-xanthine permease
ORF01291	2581 & 2582	conserved hypothetical protein
ORF01292	2583 & 2584	uracil-xanthine permease
ORF01293	2585 & 2586	4-hydroxyphenylacetate 3-monooxygenase (EC 1.14.13.3) small chain [1.14.13.3]
ORF01294	2587 & 2588	putative nitroreductase (AE005300) [1.-.-.-]
ORF01295	2589 & 2590	3-oxoadipate enol-lactone hydrolase-4-carboxymuconolactone decarboxylase, putative
ORF01296	2591 & 2592	hypothetical protein
ORF01297	2593 & 2594	endoribonuclease L-PSP, putative
ORF01298	2595 & 2596	Hypothetical isochorismatase family protein ycdL
ORF01299	2597 & 2598	bacterial luciferase family protein, putative
ORF01300	2599 & 2600	transcriptional regulator, TetR family,
ORF01301	2601 & 2602	proline dehydrogenase-delta-1-pyrroline-5-carboxylate dehydrogenase
ORF01302	2603 & 2604	conserved hypothetical protein
ORF01303	2605 & 2606	sodium-proline symporter (putP)
ORF01304	2607 & 2608	membrane protein, putative
ORF01305	2609 & 2610	putative lipoprotein
ORF01306	2611 & 2612	Tat-translocated enzyme
ORF01307	2613 & 2614	PhoH family protein
ORF01308	2615 & 2616	conserved hypothetical protein
ORF01309	2617 & 2618	haemin storage system, HmsR protein (lgtD)
ORF01310	2619 & 2620	HmsF (HmsF)
ORF01311	2621 & 2622	haemin storage system, HmsH protein

ORF01312	2623 & 2624	GGDEF domain protein
ORF01313	2625 & 2626	integrase
ORF01314	2627 & 2628	probable membrane protein
ORF01315	2629 & 2630	INSA
ORF01316	2631 & 2632	transposase
ORF01317	2633 & 2634	hypothetical protein
ORF01318	2635 & 2636	Prophage CP4-57 Regulatory protein alpA
ORF01319	2637 & 2638	conserved hypothetical protein
ORF01320	2639 & 2640	predicted methyltransferase
ORF01321	2641 & 2642	predicted methyltransferase
ORF01322	2643 & 2644	enterotoxin
ORF01323	2645 & 2646	aminotransferase, class II, putative
ORF01324	2647 & 2648	KbaY [4.1.2.-]
ORF01325	2649 & 2650	PUTATIVE TAGATOSE 6-PHOSPHATE KINASE PROTEIN
ORF01326	2651 & 2652	DeoR-family regulatory protein
ORF01327	2653 & 2654	Transcriptional regulator of sugar metabolism
ORF01328	2655 & 2656	D-galactarate dehydratase [4.2.1.42]
ORF01329	2657 & 2658	D-GALACTARATE DEHYDRATASE [4.2.1.7]
ORF01330	2659 & 2660	putative hydrolase
ORF01331	2661 & 2662	galactarate dehydrogenase [4.2.1.42]
ORF01332	2663 & 2664	hypothetical protein
ORF01333	2665 & 2666	conserved hypothetical protein
ORF01334	2667 & 2668	Putative F1C and S fimbrial switch Regulatory
ORF01335	2669 & 2670	SfaB protein
ORF01336	2671 & 2672	hypothetical protein
ORF01337	2673 & 2674	SfaD protein
ORF01338	2675 & 2676	SfaE protein
ORF01339	2677 & 2678	F1C fimbrial usher
ORF01340	2679 & 2680	S fimbrial adhesin minor subunit SfaG
ORF01341	2681 & 2682	S fimbrial adhesin minor subunit SfaS (pilin)
ORF01342	2683 & 2684	S fimbrial adhesin minor subunit SfaH
ORF01343	2685 & 2686	EAL domain, putative
ORF01344	2687 & 2688	PapX protein
ORF01345	2689 & 2690	hypothetical protein
ORF01346	2691 & 2692	IroN protein
ORF01347	2693 & 2694	IroE
ORF01348	2695 & 2696	IroD protein (Fes)
ORF01349	2697 & 2698	IroC (ABC)
ORF01350	2699 & 2700	Putative glucosyltransferase
ORF01351	2701 & 2702	conserved hypothetical protein
ORF01352	2703 & 2704	conserved hypothetical protein
ORF01353	2705 & 2706	unnamed protein product; ORF94, length (ISPlu9-p)
ORF01354	2707 & 2708	Transposase, IS4 family
ORF01355	2709 & 2710	tonB dependent outer membrane hemin receptor, hmuR (Y08983)
ORF01356	2711 & 2712	conserved hypothetical protein
ORF01357	2713 & 2714	cobalamin synthesis protein, putative
ORF01358	2715 & 2716	ECs1339
ORF01359	2717 & 2718	conserved hypothetical protein
ORF01360	2719 & 2720	hypothetical protein
ORF01361	2721 & 2722	replication protein (Rep)
ORF01362	2723 & 2724	hypothetical protein
ORF01363	2725 & 2726	YeeP protein

ORF01364	2727 & 2728	antigen43 protein orthologue
ORF01365	2729 & 2730	conserved hypothetical protein
ORF01366	2731 & 2732	Z1215 protein (o273)
ORF01367	2733 & 2734	conserved hypothetical protein
ORF01368	2735 & 2736	Antirestriction protein family
ORF01369	2737 & 2738	YeeS protein (o160)
ORF01370	2739 & 2740	intergenic-region protein-related protein
ORF01371	2741 & 2742	conserved hypothetical protein
ORF01372	2743 & 2744	intergenic-region protein
ORF01373	2745 & 2746	YeeV protein
ORF01374	2747 & 2748	L0008-like protein
ORF01375	2749 & 2750	Z1225 protein (AF071034)
ORF01376	2751 & 2752	Z1226 protein
ORF01377	2753 & 2754	putative dehydrogenase (AE005314)
ORF01378	2755 & 2756	PHP family protein
ORF01379	2757 & 2758	TorD protein
ORF01380	2759 & 2760	Protein of unknown function (DUF1097) superfamily
ORF01381	2761 & 2762	Curli production assembly-transport component csgG precursor
ORF01382	2763 & 2764	Curli production assembly-transport component csgF precursor
ORF01383	2765 & 2766	Curli production assembly-transport component csgE precursor
ORF01384	2767 & 2768	transcriptional regulator, LuxR family
ORF01385	2769 & 2770	curli fiber major subunit CsgA, degenerate
ORF01386	2771 & 2772	curli fiber major subunit CsgA, degenerate, putative
ORF01387	2773 & 2774	conserved hypothetical protein
ORF01388	2775 & 2776	Appr-1-p processing enzyme family protein
ORF01389	2777 & 2778	cardiolipin synthase
ORF01390	2779 & 2780	Glucans biosynthesis protein C [2.1.-.-]
ORF01391	2781 & 2782	conserved hypothetical protein
ORF01392	2783 & 2784	Periplasmic glucans biosynthesis protein mdoG precursor
ORF01393	2785 & 2786	Periplasmic glucans biosynthesis protein mdoH
ORF01394	2787 & 2788	conserved hypothetical protein
ORF01395	2789 & 2790	Protein of unknown function (DUF1375) superfamily
ORF01396	2791 & 2792	Acidic protein msyB
ORF01397	2793 & 2794	major facilitator family transporter
ORF01398	2795 & 2796	Lipid A biosynthesis lauroyl acyltransferase
ORF01399	2797 & 2798	rhodanese-like domain protein, putative
ORF01400	2799 & 2800	Protein ycel precursor
ORF01401	2801 & 2802	Cytochrome b561 homolog 2
ORF01402	2803 & 2804	conserved hypothetical protein
ORF01403	2805 & 2806	N-methyl-L-tryptophan oxidase (MTOX) [1.5.3.-]
ORF01404	2807 & 2808	unnamed protein product; ORF_ID:o233#8
ORF01405	2809 & 2810	unnamed protein product; ORF_ID:o233#9
ORF01406	2811 & 2812	dihydroorotase, homodimeric type (pyrC) [3.5.2.3]
ORF01407	2813 & 2814	Protein of unknown function (DUF1439) superfamily
ORF01408	2815 & 2816	Glutaredoxin, GrxB family (grxB)
ORF01409	2817 & 2818	Major Facilitator Superfamily subfamily
ORF01410	2819 & 2820	Ribosomal-protein-alanine acetyltransferase [2.3.1.128]
ORF01411	2821 & 2822	g20.3
ORF01412	2823 & 2824	putative virulence factor
ORF01413	2825 & 2826	integral membrane protein MviN (mviN)
ORF01414	2827 & 2828	Flagella synthesis protein flgN

ORF01415	2829 & 2830	Negative regulator of flagellin synthesis (Anti-sigma-28 factor)
ORF01416	2831 & 2832	flagellar basal body P-ring protein FlgA precursor
ORF01417	2833 & 2834	flagellar basal-body rod protein FlgB (flgB)
ORF01418	2835 & 2836	flagellar basal-body rod protein FlgC (flgC)
ORF01419	2837 & 2838	flagellar biosynthesis, hook protein
ORF01420	2839 & 2840	flagellar biosynthesis, hook protein
ORF01421	2841 & 2842	Flagellar basal-body rod protein flgF
ORF01422	2843 & 2844	Flagellar basal-body rod protein flgG (Distal rod protein)
ORF01423	2845 & 2846	flagellar L-ring protein FlgH (flgH)
ORF01424	2847 & 2848	flagellar P-ring protein FlgI (flgI)
ORF01425	2849 & 2850	Peptidoglycan hydrolase flgJ [3.2.1.-]
ORF01426	2851 & 2852	flagellar hook-associated protein 1 (hap1)
ORF01427	2853 & 2854	Flagellar hook-associated protein 3 (hap3)
ORF01428	2855 & 2856	Ribonuclease E (RNase E) (rne) [3.1.4.-]
ORF01429	2857 & 2858	hypothetical protein
ORF01430	2859 & 2860	ribosomal large subunit pseudouridine synthase C (orfx) [4.2.1.70]
ORF01431	2861 & 2862	ribosomal large subunit pseudouridine synthase C (orfx) [4.2.1.70]
ORF01432	2863 & 2864	maf protein (maf)
ORF01433	2865 & 2866	Uncharacterized ACR, COG1399
ORF01434	2867 & 2868	ribosomal protein L32 (rpmF)
ORF01435	2869 & 2870	3-oxoacyl-[acyl-carrier-protein] synthase II
ORF01436	2871 & 2872	Aminodeoxychorismate lyase (4-amino-4-deoxychorismatelyase) (ADC lyase) (ADCL) (ADCL) [4.1.3.38]
ORF01437	2873 & 2874	conserved hypothetical protein TIGR00247
ORF01438	2875 & 2876	thymidylate kinase (tmk) [2.7.4.9]
ORF01439	2877 & 2878	DNA polymerase III, delta' subunit [2.7.7.7]
ORF01440	2879 & 2880	Putative deoxyribonuclease ycfH
ORF01441	2881 & 2882	PTS system, glucose-specific IIBC component (ptsG) [2.7.1.69]
ORF01442	2883 & 2884	FhuE receptor precursor (III)
ORF01443	2885 & 2886	HIT-like protein ycfF (Ap4A)
ORF01444	2887 & 2888	Protein of unknown function (DUF1425) superfamily
ORF01445	2889 & 2890	Fibronectin-binding protein B
ORF01446	2891 & 2892	unnamed protein product [3.2.1.21]
ORF01447	2893 & 2894	Beta-hexosaminidase
ORF01448	2895 & 2896	ycfP protein
ORF01449	2897 & 2898	NADH dehydrogenase
ORF01450	2899 & 2900	conserved hypothetical protein
ORF01451	2901 & 2902	transcriptional regulator, TetR family
ORF01452	2903 & 2904	Protein of unknown function (DUF1471) superfamily
ORF01453	2905 & 2906	ErfK-YbiS-YcfS-YnhG family
ORF01454	2907 & 2908	transcription-repair coupling factor mutation frequency decline
ORF01455	2909 & 2910	Acyltransferase family, putative
ORF01456	2911 & 2912	hypothetical protein
ORF01457	2913 & 2914	ABC transporter, integral membrane protein
ORF01458	2915 & 2916	lipoprotein releasing system, ATP-binding protein (lolD)
ORF01459	2917 & 2918	lipoprotein releasing system, transmembrane protein LolE (lolE)
ORF01460	2919 & 2920	ROK family protein
ORF01461	2921 & 2922	NAD-dependent deacetylase (Regulatory protein SIR2homolog) (DMB) [3.5.1.-]
ORF01462	2923 & 2924	conserved hypothetical protein
ORF01463	2925 & 2926	conserved hypothetical protein

ORF01464	2927 & 2928	Spermidine-putrescine-binding periplasmic protein precursor (potD)
ORF01465	2929 & 2930	Spermidine-putrescine transport system permease protein potC (potC)
ORF01466	2931 & 2932	spermidine-putrescine transport system permease
ORF01467	2933 & 2934	ABC transporter, polyamine transport protein, ATP-binding protein (atp_bind)
ORF01468	2935 & 2936	peptidase T (pepT) [3.4.11.14]
ORF01469	2937 & 2938	ycfD protein
ORF01470	2939 & 2940	Sensor protein phoQ [2.7.3.-]
ORF01471	2941 & 2942	transcriptional regulatory protein
ORF01472	2943 & 2944	adenylosuccinate lyase (purB) [4.3.2.2]
ORF01473	2945 & 2946	Uncharacterized protein involved in purine metabolism
ORF01474	2947 & 2948	tRNA (5-methylaminomethyl-2-thiouridylate)-methyltransferase (trmU) [2.1.1.61]
ORF01475	2949 & 2950	unnamed protein product [3.6.-.-]
ORF01476	2951 & 2952	RNA pseudouridylate synthase family protein [4.2.1.70]
ORF01477	2953 & 2954	conserved hypothetical protein
ORF01478	2955 & 2956	isocitrate dehydrogenase, NADP-dependent (icd) [1.1.1.42]
ORF01479	2957 & 2958	Prophage lambda integrase
ORF01480	2959 & 2960	conserved hypothetical protein
ORF01481	2961 & 2962	unnamed protein product; Some similarities with bacteriophage protein
ORF01482	2963 & 2964	exonuclease Z0951 [similarity] [3.1.11.3]
ORF01483	2965 & 2966	recombination protein Bet
ORF01484	2967 & 2968	Host-nuclease inhibitor protein Gam
ORF01485	2969 & 2970	Kil protein
ORF01486	2971 & 2972	Lambda Regulatory protein CIII-related protein
ORF01487	2973 & 2974	Ea10 gene protein
ORF01488	2975 & 2976	conserved hypothetical protein
ORF01489	2977 & 2978	antitermination protein Q
ORF01490	2979 & 2980	lysozyme [3.2.1.17]
ORF01491	2981 & 2982	Bacteriophage lysis protein
ORF01492	2983 & 2984	hypothetical protein
ORF01493	2985 & 2986	prophage L54a, HNH endonuclease family protein
ORF01494	2987 & 2988	small terminase subunit
ORF01495	2989 & 2990	phage terminase, large subunit, putative
ORF01496	2991 & 2992	conserved hypothetical protein
ORF01497	2993 & 2994	phage portal protein, HK97 family
ORF01498	2995 & 2996	Sb5 (AF181080)
ORF01499	2997 & 2998	phage major capsid protein, HK97 family
ORF01500	2999 & 3000	Sb7-related protein
ORF01501	3001 & 3002	Sb8
ORF01502	3003 & 3004	Sb9
ORF01503	3005 & 3006	hypothetical protein
ORF01504	3007 & 3008	Sb11
ORF01505	3009 & 3010	conserved hypothetical protein
ORF01506	3011 & 3012	Bacteriophage Mu tail sheath protein (GpL)
ORF01507	3013 & 3014	Sb14
ORF01508	3015 & 3016	hypothetical protein
ORF01509	3017 & 3018	Sb15
ORF01510	3019 & 3020	tail protein
ORF01511	3021 & 3022	tail-DNA circulation protein (muN)
ORF01512	3023 & 3024	Bacteriophage Mu P protein
ORF01513	3025 & 3026	Bacteriophage Mu Gp45 protein
ORF01514	3027 & 3028	Phage protein GP46
ORF01515	3029 & 3030	tail protein

ORF01516	3031 & 3032	tail protein
ORF01517	3033 & 3034	ycfE protein (fragment)
ORF01518	3035 & 3036	Domain of unknown function DUF144 superfamily
ORF01519	3037 & 3038	unnamed protein product; unidentified reading frame P-293
ORF01520	3039 & 3040	lipoprotein Rz1 precursor -related protein
ORF01521	3041 & 3042	Bacteriophage lysis protein
ORF01522	3043 & 3044	Bor protein homolog from lambdoid prophage DLP12
ORF01523	3045 & 3046	hypothetical protein
ORF01524	3047 & 3048	conserved hypothetical protein
ORF01525	3049 & 3050	Bacteriophage lambda head decoration protein D
ORF01526	3051 & 3052	Phage major capsid protein E
ORF01527	3053 & 3054	conserved hypothetical protein
ORF01528	3055 & 3056	Phage Head-Tail Attachment
ORF01529	3057 & 3058	Prophage minor tail protein Z (GPZ)
ORF01530	3059 & 3060	Minor tail protein U
ORF01531	3061 & 3062	hypothetical protein
ORF01532	3063 & 3064	Minor tail protein Z (GPZ)
ORF01533	3065 & 3066	Phage minor tail protein U
ORF01534	3067 & 3068	minor tail protein
ORF01535	3069 & 3070	Phage minor tail protein U
ORF01536	3071 & 3072	major tail protein
ORF01537	3073 & 3074	phage minor tail protein G
ORF01538	3075 & 3076	minor tail protein
ORF01539	3077 & 3078	minor tail protein
ORF01540	3079 & 3080	tail length tape measure protein precursor
ORF01541	3081 & 3082	minor tail protein
ORF01542	3083 & 3084	Minor tail protein precursor H
ORF01543	3085 & 3086	Minor tail protein precursor H
ORF01544	3087 & 3088	hypothetical bacteriophage protein
ORF01545	3089 & 3090	unnamed protein product; Similar to tail fiber assembly protein
ORF01546	3091 & 3092	Protease VII precursor (Omptin) (Outer membrane protein3B) (Protease A) (SopA) [3.4.21.87]
ORF01547	3093 & 3094	Protease VII precursor (Omptin) (Outer membrane protein3B) (Protease A) (SopA) [3.4.21.87]
ORF01548	3095 & 3096	Protease VII precursor (Omptin) (Outer membrane protein3B) (Protease A) (SopA) [3.4.21.87]
ORF01549	3097 & 3098	ydfE protein (35kD)
ORF01550	3099 & 3100	Phage terminase large subunit (GpA)
ORF01551	3101 & 3102	Phage terminase large subunit (GpA)
ORF01552	3103 & 3104	Phage terminase large subunit (GpA)
ORF01553	3105 & 3106	Portal protein (Head protein GP4)
ORF01554	3107 & 3108	head-tail preconnector protein GP5
ORF01555	3109 & 3110	Head-tail preconnector protein GP5 [Contains: Scaffold protein GP6(Head protein GP6)]
ORF01556	3111 & 3112	Bacteriophage lambda head decoration protein D
ORF01557	3113 & 3114	Phage major capsid protein E
ORF01558	3115 & 3116	conserved hypothetical protein
ORF01559	3117 & 3118	Phage Head-Tail Attachment
ORF01560	3119 & 3120	Prophage minor tail protein Z (GPZ)
ORF01561	3121 & 3122	Phage minor tail protein U
ORF01562	3123 & 3124	major tail protein

ORF01563	3125 & 3126	phage minor tail protein G
ORF01564	3127 & 3128	minor tail protein
ORF01565	3129 & 3130	Portal protein (Head protein GP4)
ORF01566	3131 & 3132	head-tail preconnector protein GP5
ORF01567	3133 & 3134	Head-tail preconnector protein GP5 [Contains: Scaffold protein GP6(Head protein GP6)]
ORF01568	3135 & 3136	Head-tail preconnector protein GP5 [Contains: Scaffold protein GP6(Head protein GP6)]
ORF01569	3137 & 3138	Bacteriophage lambda head decoration protein D
ORF01570	3139 & 3140	phage tail tape measure protein, lambda family
ORF01571	3141 & 3142	Phage minor tail protein
ORF01572	3143 & 3144	minor tail protein
ORF01573	3145 & 3146	Putative tail component of prophage
ORF01574	3147 & 3148	Phage minor tail protein
ORF01575	3149 & 3150	Phage minor tail protein L
ORF01576	3151 & 3152	Putative tail component of prophage
ORF01577	3153 & 3154	Phage minor tail protein
ORF01578	3155 & 3156	Phage minor tail protein L
ORF01579	3157 & 3158	transcriptional regulator, GntR family
ORF01580	3159 & 3160	Probable oxidoreductase ydfG
ORF01581	3161 & 3162	peptidyl-dipeptidase Dcp, putative
ORF01582	3163 & 3164	peptidyl-dipeptidase Dcp
ORF01583	3165 & 3166	hypothetical protein
ORF01584	3167 & 3168	GGDEF domain protein
ORF01585	3169 & 3170	hypothetical protein
ORF01586	3171 & 3172	Major Facilitator Superfamily subfamily
ORF01587	3173 & 3174	YdeD
ORF01588	3175 & 3176	Putative conserved protein
ORF01589	3177 & 3178	PTS system, cellobiose-specific IIB component (PTS) [2.7.1.69]
ORF01590	3179 & 3180	Putative conserved protein
ORF01591	3181 & 3182	PTS system, cellobiose-specific IIA component
ORF01592	3183 & 3184	f538
ORF01593	3185 & 3186	6-phospho-beta-glucosidase
ORF01594	3187 & 3188	Multiple antibiotic resistance protein marB-related protein
ORF01595	3189 & 3190	multiple antibiotic resistance protein MarA
ORF01596	3191 & 3192	Multiple antibiotic resistance protein marR (AL359989)
ORF01597	3193 & 3194	conserved hypothetical protein TIGR00427
ORF01598	3195 & 3196	Sugar efflux transporter
ORF01599	3197 & 3198	transcriptional regulator, LysR family
ORF01600	3199 & 3200	Aldehyde-dehydrogenase like protein ynel (SSDH) [1.2.1.-]
ORF01601	3201 & 3202	glutaminase family protein, interruption-N
ORF01602	3203 & 3204	conserved hypothetical protein
ORF01603	3205 & 3206	GGDEF domain protein
ORF01604	3207 & 3208	altronate oxidoreductase
ORF01605	3209 & 3210	Uncharacterised protein family (UPF0187) superfamily
ORF01606	3211 & 3212	trans-aconitate methyltransferase [2.1.1.144]
ORF01607	3213 & 3214	Protein hipB
ORF01608	3215 & 3216	Protein hipA
ORF01609	3217 & 3218	conserved hypothetical protein
ORF01610	3219 & 3220	short chain dehydrogenase
ORF01611	3221 & 3222	Type-1 fimbrial protein, A chain precursor
ORF01612	3223 & 3224	Chaperone protein fimC precursor

ORF01613	3225 & 3226	Outer membrane usher protein fimD precursor
ORF01614	3227 & 3228	fimbrial morphology
ORF01615	3229 & 3230	Hypothetical fimbrial-like protein ydeQ precursor
ORF01616	3231 & 3232	oxidoreductase alpha (molybdopterin) subunit
ORF01617	3233 & 3234	HTH-type transcriptional regulator ydeO
ORF01618	3235 & 3236	arylsulfatase B (GALNS)
ORF01619	3237 & 3238	radical SAM domain protein protein
ORF01620	3239 & 3240	ABC efflux transporter, permease-ATP-binding protein, putative
ORF01621	3241 & 3242	cds103
ORF01622	3243 & 3244	cds103
ORF01623	3245 & 3246	peptidase, M16 family, putative [3.4.99.-]
ORF01624	3247 & 3248	glutamate decarboxylase [4.1.1.15]
ORF01625	3249 & 3250	Amino acid antiporter
ORF01626	3251 & 3252	yngK protein
ORF01627	3253 & 3254	Putative conserved protein-related protein
ORF01628	3255 & 3256	Sensor protein FixL (EC 2.7.3.-). (nifL) [2.7.3.-]
ORF01629	3257 & 3258	protein C, osmotically inducible
ORF01630	3259 & 3260	hypothetical protein
ORF01631	3261 & 3262	conserved hypothetical protein
ORF01632	3263 & 3264	conserved hypothetical protein
ORF01633	3265 & 3266	30S ribosomal protein S22 (Stationary-phase-induced ribosome-associated protein) (SRA) (Protein D)-related protein
ORF01634	3267 & 3268	hypothetical protein
ORF01635	3269 & 3270	NAD-linked malate dehydrogenase (malic enzyme)
ORF01636	3271 & 3272	alcohol dehydrogenase, propanol-preferring (adhA) [1.-.-.-]
ORF01637	3273 & 3274	proteic killer suppression protein hig A
ORF01638	3275 & 3276	conserved hypothetical protein
ORF01639	3277 & 3278	proteic killer active protein hig B
ORF01640	3279 & 3280	formate dehydrogenase, gamma subunit [1.2.1.2]
ORF01641	3281 & 3282	formate dehydrogenase, beta subunit (FdxH) [1.2.1.2]
ORF01642	3283 & 3284	formate dehydrogenase, alpha subunit, selenocysteine-containing [1.2.1.2]
ORF01643	3285 & 3286	formate dehydrogenase, alpha subunit, selenocysteine-containing [1.2.1.2]
ORF01644	3287 & 3288	formate dehydrogenase, alpha subunit, selenocysteine-containing [1.2.1.2]
ORF01645	3289 & 3290	hypothetical protein
ORF01646	3291 & 3292	membrane protein yddG
ORF01647	3293 & 3294	nitrite extrusion protein 2
ORF01648	3295 & 3296	nitrate reductase, alpha subunit [1.7.99.4]
ORF01649	3297 & 3298	nitrate reductase, beta subunit (narH) [1.7.99.4]
ORF01650	3299 & 3300	Respiratory nitrate reductase 2 delta chain [1.7.99.4]
ORF01651	3301 & 3302	respiratory nitrate reductase, gamma subunit (narI) [1.7.99.4]
ORF01652	3303 & 3304	phenazine biosynthesis protein PhzF family subfamily
ORF01653	3305 & 3306	Chain D, M. Smegmatis Arylamine N-Acetyl Transferase [2.3.1.118]
ORF01654	3307 & 3308	Flavin reductase like domain protein
ORF01655	3309 & 3310	H repeat-associated protein (ORF-H)
ORF01656	3311 & 3312	conserved hypothetical protein
ORF01657	3313 & 3314	conserved hypothetical protein
ORF01658	3315 & 3316	Aec15 (AF044503)
ORF01659	3317 & 3318	Uncharacterized conserved protein
ORF01660	3319 & 3320	probable transferase (U59485)
ORF01661	3321 & 3322	glutathione S-transferase gst
ORF01662	3323 & 3324	L-asparagine permease (516aa)
ORF01663	3325 & 3326	conserved hypothetical protein

ORF01664	3327 & 3328	TonB-dependent receptor protein
ORF01665	3329 & 3330	Putative conserved protein-related protein
ORF01666	3331 & 3332	acetyltransferase, GNAT family [2.3.1.-]
ORF01667	3333 & 3334	Protein of unknown function, DUF606 superfamily
ORF01668	3335 & 3336	conserved hypothetical protein
ORF01669	3337 & 3338	conserved hypothetical protein
ORF01670	3339 & 3340	hypothetical protein
ORF01671	3341 & 3342	aldehyde dehydrogenase family protein (BADH) [1.2.1.8]
ORF01672	3343 & 3344	polyamine ABC transporter, permease protein
ORF01673	3345 & 3346	polyamine ABC transporter, permease protein
ORF01674	3347 & 3348	polyamine ABC transporter, ATP-binding protein
ORF01675	3349 & 3350	polyamine ABC transporter, periplasmic polyamine-binding protein
ORF01676	3351 & 3352	unnamed protein product (TAT) [2.6.1.5]
ORF01677	3353 & 3354	unnamed protein product
ORF01678	3355 & 3356	conserved hypothetical protein
ORF01679	3357 & 3358	peptidase, U32 family
ORF01680	3359 & 3360	transcriptional regulator, Cro-CI family, putative
ORF01681	3361 & 3362	similar to benzoate transport protein
ORF01682	3363 & 3364	Hypothetical lipoprotein ydcL precursor
ORF01683	3365 & 3366	tellurite resistance protein TehB (tehB)
ORF01684	3367 & 3368	Tellurite resistance protein tehA
ORF01685	3369 & 3370	ribosomal-protein-serine acetyltransferase, putative
ORF01686	3371 & 3372	conserved hypothetical protein
ORF01687	3373 & 3374	Protein of unknown function (DUF465) family
ORF01688	3375 & 3376	Glucans biosynthesis protein D precursor
ORF01689	3377 & 3378	Protein of unknown function (DUF1338) family
ORF01690	3379 & 3380	transcriptional regulator PcaQ
ORF01691	3381 & 3382	methyl-accepting chemotaxis protein II, aspartate sensor receptor
ORF01692	3383 & 3384	Hok protein.-related protein
ORF01693	3385 & 3386	conserved hypothetical protein
ORF01694	3387 & 3388	Cytochrome b561 (561)
ORF01695	3389 & 3390	glyceraldehyde-3-phosphate dehydrogenase, type I (gap) [1.2.1.-]
ORF01696	3391 & 3392	Aldehyde dehydrogenase A (NAD) [1.2.1.22]
ORF01697	3393 & 3394	Protein ydcF
ORF01698	3395 & 3396	ATP-dependent helicase HrpA (hrpA)
ORF01699	3397 & 3398	[acyl-carrier-protein] phosphodiesterase acpD (fragment) [3.1.4.14]
ORF01700	3399 & 3400	Dual specificity phosphatase, catalytic domain protein
ORF01701	3401 & 3402	Lysophospholipase
ORF01702	3403 & 3404	phosphatidate cytidylyltransferase (cdsA) [2.7.7.41]
ORF01703	3405 & 3406	CDP-alcohol phosphatidyltransferase family
ORF01704	3407 & 3408	oxidoreductase, aldo-keto reductase family [1.-.-.-]
ORF01705	3409 & 3410	split orf
ORF01706	3411 & 3412	Protein of unknown function (DUF1318) family
ORF01707	3413 & 3414	lipoprotein, putative
ORF01708	3415 & 3416	unnamed protein product; Similar to membrane protein YdbH of Escherichia coli
ORF01709	3417 & 3418	fermentative D-lactate dehydrogenase (D-LDH) [1.1.1.28]
ORF01710	3419 & 3420	Heat shock protein hslJ
ORF01711	3421 & 3422	lipoprotein, putative
ORF01712	3423 & 3424	pyruvate:ferredoxin (flavodoxin) oxidoreductase (nifJ) [1.2.7.1]
ORF01713	3425 & 3426	Outer membrane protein N precursor (Ibc)
ORF01714	3427 & 3428	putative filament protein
ORF01715	3429 & 3430	integrase for bacteriophage BP-933W

ORF01716	3431 & 3432	YdaO protein
ORF01717	3433 & 3434	ATP-independent RNA helicase dbpA
ORF01718	3435 & 3436	hypothetical protein
ORF01719	3437 & 3438	CorA-like Mg2+ transporter protein
ORF01720	3439 & 3440	Diguanylate cyclase-phosphodiesterase domain 1 (GGDEF)
ORF01721	3441 & 3442	Smr domain protein
ORF01722	3443 & 3444	drug resistance transporter, Bcr-CflA family (emrB)
ORF01723	3445 & 3446	HlyD family secretion protein
ORF01724	3447 & 3448	transcriptional regulator, AraC family
ORF01725	3449 & 3450	conserved hypothetical protein
ORF01726	3451 & 3452	Methylated-DNA--protein-cysteine methyltransferase (6-O-methylguanine-DNA methyltransferase) (MGMT) (O-6-methylguanine-DNA-alkyltransferase) [2.1.1.63]
ORF01727	3453 & 3454	Fumarate and nitrate reduction Regulatory protein
ORF01728	3455 & 3456	universal stress protein family domain protein
ORF01729	3457 & 3458	conserved hypothetical protein
ORF01730	3459 & 3460	small-conductance mechanosensitive channel
ORF01731	3461 & 3462	Periplasmic murein peptide-binding protein precursor
ORF01732	3463 & 3464	Xanthosine operon regulatory protein.
ORF01733	3465 & 3466	dienelactone hydrolase domain protein
ORF01734	3467 & 3468	conserved hypothetical protein
ORF01735	3469 & 3470	Mandelate racemase - muconate lactonizing enzyme, C-terminal domain protein
ORF01736	3471 & 3472	YcjI
ORF01737	3473 & 3474	thiol peroxidase (P20) [1.11.1.-]
ORF01738	3475 & 3476	Transcriptional Regulatory protein tyrR
ORF01739	3477 & 3478	conserved hypothetical protein TIGR01620
ORF01740	3479 & 3480	YcjX (AY008264)
ORF01741	3481 & 3482	transcription regulator homolog lin2974
ORF01742	3483 & 3484	Outer membrane protein G precursor
ORF01743	3485 & 3486	ABC transporter domain protein
ORF01744	3487 & 3488	beta-phosphoglucomutase (pgmB) [5.4.2.6]
ORF01745	3489 & 3490	maltose phosphorylase homolog lin2966 (phosphorylase) [3.2.1.-]
ORF01746	3491 & 3492	oxidoreductase, Gfo-Idh-MocA family
ORF01747	3493 & 3494	an E.coli protein homolog lin2968 [5.3.1.-]
ORF01748	3495 & 3496	Alcohol dehydrogenase (EC 1.1.1.1). [1.1.1.-]
ORF01749	3497 & 3498	ABC transporter, permease protein (AF175299)
ORF01750	3499 & 3500	Sn-glycerol-3-phosphate transport system permease protein UgpA. (AF307052)
ORF01751	3501 & 3502	ABC transporter, substrate-binding protein
ORF01752	3503 & 3504	dextransucrase (EC 2.4.1.5) , putative [2.4.1.5]
ORF01753	3505 & 3506	rhodanese-like domain protein
ORF01754	3507 & 3508	phage shock protein-related protein
ORF01755	3509 & 3510	Phage shock protein C
ORF01756	3511 & 3512	phage shock protein B
ORF01757	3513 & 3514	Phage shock protein A
ORF01758	3515 & 3516	Psp operon transcriptional activator
ORF01759	3517 & 3518	probable amino acid permease ycjJ
ORF01760	3519 & 3520	conserved hypothetical protein
ORF01761	3521 & 3522	Peptide transport periplasmic protein sapA precursor
ORF01762	3523 & 3524	Peptide transport system permease protein sapB
ORF01763	3525 & 3526	Peptide transport system permease protein sapC (sapC)
ORF01764	3527 & 3528	Peptide transport system ATP-binding protein sapD
ORF01765	3529 & 3530	Peptide transport system ATP-binding protein sapF
ORF01766	3531 & 3532	drug resistance transporter, Bcr-CflA family protein

ORF01767	3533 & 3534	EefC outer membrane protein
ORF01768	3535 & 3536	Acriflavine resistance protein B
ORF01769	3537 & 3538	Acriflavine resistance protein A precursor (MFP)
ORF01770	3539 & 3540	transcriptional regulator, TetR family
ORF01771	3541 & 3542	enoyl-[acyl-carrier-protein] reductase ECs1861 (NADH) [1.3.1.9]
ORF01772	3543 & 3544	conserved hypothetical protein
ORF01773	3545 & 3546	exoribonuclease II (rnb) [3.1.13.1]
ORF01774	3547 & 3548	sensory box protein
ORF01775	3549 & 3550	conserved hypothetical protein
ORF01776	3551 & 3552	glycerol-3-phosphate regulon repressor, putative
ORF01777	3553 & 3554	Osmotically inducible lipoprotein B precursor-related protein
ORF01778	3555 & 3556	translation initation factor SUI1, putative
ORF01779	3557 & 3558	orotidine 5'-phosphate decarboxylase (pyrF) [4.1.1.23]
ORF01780	3559 & 3560	hypothetical protein
ORF01781	3561 & 3562	predicted N-acetylglucosaminyl transferase
ORF01782	3563 & 3564	unnamed protein product
ORF01783	3565 & 3566	Phosphatidylglycerophosphatase B (pgpB) [3.1.3.27]
ORF01784	3567 & 3568	GTP cyclohydrolase II (ribA) [3.5.4.25]
ORF01785	3569 & 3570	aconitate hydratase 1 (acnA) [4.2.1.3]
ORF01786	3571 & 3572	conserved hypothetical protein
ORF01787	3573 & 3574	conserved hypothetical protein
ORF01788	3575 & 3576	HTH-type transcriptional regulator cysB (Cys regulon transcriptionalactivator)
ORF01789	3577 & 3578	DNA topoisomerase I
ORF01790	3579 & 3580	hypothetical protein
ORF01791	3581 & 3582	Protein yciN
ORF01792	3583 & 3584	Possible protease sohB
ORF01793	3585 & 3586	Oxidoreductase [1.-.-.-]
ORF01794	3587 & 3588	cob(I)alamin adenosyltransferase (cobO) [2.5.1.17]
ORF01795	3589 & 3590	RNA pseudouridylate synthase family protein [4.2.1.70]
ORF01796	3591 & 3592	conserved hypothetical protein
ORF01797	3593 & 3594	Sua5-YciO-YrdC-YwlC family protein
ORF01798	3595 & 3596	Protein trpH
ORF01799	3597 & 3598	anthranilate synthase component I (trpE) [4.1.3.27]
ORF01800	3599 & 3600	Anthranilate synthase component II [4.1.3.27]
ORF01801	3601 & 3602	anthranilate isomerase (PRAI) [4.1.1.48]
ORF01802	3603 & 3604	tryptophan synthase, beta subunit (trpB) [4.2.1.20]
ORF01803	3605 & 3606	tryptophan synthase, alpha subunit (trpA) [4.2.1.20]
ORF01804	3607 & 3608	conserved hypothetical protein
ORF01805	3609 & 3610	Protein yciF
ORF01806	3611 & 3612	yciE
ORF01807	3613 & 3614	Outer membrane protein W precursor
ORF01808	3615 & 3616	Tail fiber assembly protein homolog from lambdoid prophage
ORF01809	3617 & 3618	Tail fiber assembly protein homolog from lambdoid prophage Qin
ORF01810	3619 & 3620	probable membrane protein of prophage CP-933X Z1918
ORF01811	3621 & 3622	probable membrane protein of prophage CP-933X Z1918
ORF01812	3623 & 3624	unknown protein encoded by prophage CP-933X
ORF01813	3625 & 3626	hypothetical protein
ORF01814	3627 & 3628	Lom
ORF01815	3629 & 3630	host specificity protein (partial)
ORF01816	3631 & 3632	Host specificity protein J (partial)
ORF01817	3633 & 3634	Bacteriophage lambda tail assembly protein I

ORF01818	3635 & 3636	Putative tail fiber component K of prophage
ORF01819	3637 & 3638	minor tail protein
ORF01820	3639 & 3640	minor tail protein
ORF01821	3641 & 3642	Phage minor tail protein
ORF01822	3643 & 3644	Minor tail protein precursor H
ORF01823	3645 & 3646	minor tail protein
ORF01824	3647 & 3648	phage minor tail protein G
ORF01825	3649 & 3650	Bacterial Ig-like domain (group 2) family
ORF01826	3651 & 3652	Phage minor tail protein U
ORF01827	3653 & 3654	Prophage minor tail protein Z (GPZ)
ORF01828	3655 & 3656	Phage Head-Tail Attachment
ORF01829	3657 & 3658	conserved hypothetical protein
ORF01830	3659 & 3660	Phage major capsid protein E
ORF01831	3661 & 3662	Bacteriophage lambda head decoration protein D
ORF01832	3663 & 3664	head-tail preconnector protein GP5
ORF01833	3665 & 3666	phage portal protein, lambda family
ORF01834	3667 & 3668	gpW
ORF01835	3669 & 3670	Phage terminase large subunit (GpA)
ORF01836	3671 & 3672	Terminase small subunit (GP1) (fragment)
ORF01837	3673 & 3674	hypothetical protein
ORF01838	3675 & 3676	Bacteriophage lysis protein
ORF01839	3677 & 3678	lipoprotein Rz1 precursor -related protein
ORF01840	3679 & 3680	putative bacteriophage protein
ORF01841	3681 & 3682	Lysozyme (Lysis protein) (Muramidase) (Endolysin) [3.2.1.17]
ORF01842	3683 & 3684	Protein of unknown function (DUF1327) superfamily
ORF01843	3685 & 3686	Lysis protein S homolog from lambdoid prophage
ORF01844	3687 & 3688	unnamed protein product; ORF616
ORF01845	3689 & 3690	unnamed protein product; ORF616
ORF01846	3691 & 3692	DNA adenine-methylase
ORF01847	3693 & 3694	unknown protein encoded by prophage CP-933O
ORF01848	3695 & 3696	Antitermination protein Q homolog of cryptic prophage
ORF01849	3697 & 3698	endodeoxyribonuclease RUS (Holliday junction resolvase) [3.1.22.-]
ORF01850	3699 & 3700	Protein of unknown function (DUF1277) superfamily
ORF01851	3701 & 3702	prophage maintenance protein [similarity]-related protein
ORF01852	3703 & 3704	hypothetical protein
ORF01853	3705 & 3706	conserved hypothetical protein
ORF01854	3707 & 3708	Unknown protein encoded within prophage
ORF01855	3709 & 3710	conserved hypothetical protein
ORF01856	3711 & 3712	Unknown protein encoded by cryptic prophage
ORF01857	3713 & 3714	Peptidase S24-like domain, putative
ORF01858	3715 & 3716	Protein of unknown function (DUF1391) family
ORF01859	3717 & 3718	ydfB protein-related protein
ORF01860	3719 & 3720	conserved hypothetical protein
ORF01861	3721 & 3722	hypothetical protein
ORF01862	3723 & 3724	Division inhibition protein dicB
ORF01863	3725 & 3726	unknown protein encoded by prophage CP-933O -related protein
ORF01864	3727 & 3728	Exodeoxyribonuclease VIII (35kD) [3.1.11.-]
ORF01865	3729 & 3730	integrase
ORF01866	3731 & 3732	Outer membrane protein W precursor
ORF01867	3733 & 3734	yciC
ORF01868	3735 & 3736	intracellular septation protein A (ispZ)
ORF01869	3737 & 3738	acyl-CoA hydrolase [3.1.2.-]

ORF01870	3739 & 3740	TonB protein
ORF01871	3741 & 3742	ycil protein
ORF01872	3743 & 3744	Putative potassium channel protein
ORF01873	3745 & 3746	Cardiolipin synthetase (Cardiolipin synthase) (CLsynthase) [2.7.8.-]
ORF01874	3747 & 3748	Protein of unknown function, DUF440 superfamily
ORF01875	3749 & 3750	peptide ABC transporter, ATP-binding protein (AA1)
ORF01876	3751 & 3752	oligopeptide ABC transporter, ATP-binding protein (AA1)
ORF01877	3753 & 3754	oligopeptide ABC transporter, permease protein (AA1)
ORF01878	3755 & 3756	Oligopeptide transport system permease protein oppB (AA1)
ORF01879	3757 & 3758	Periplasmic oligopeptide-binding protein precursor
ORF01880	3759 & 3760	membrane protein, putative
ORF01881	3761 & 3762	acetaldehyde dehydrogenase (acetylating) - alcohol dehydrogenase (EC 1.1.1.1) (ACDH) [1.2.1.10]
ORF01882	3763 & 3764	Transposase insG for insertion sequence element IS4
ORF01883	3765 & 3766	thymidine kinase [2.7.1.21]
ORF01884	3767 & 3768	conserved hypothetical protein
ORF01885	3769 & 3770	DNA-binding protein H-NS homolog virR
ORF01886	3771 & 3772	UTP-glucose-1-phosphate uridylyltransferase (galU) [2.7.7.9]
ORF01887	3773 & 3774	Hnr protein
ORF01888	3775 & 3776	drug transporter
ORF01889	3777 & 3778	unnamed protein product
ORF01890	3779 & 3780	formyltetrahydrofolate deformylase (purU) [3.5.1.10]
ORF01891	3781 & 3782	Tpn1330 protein
ORF01892	3783 & 3784	respiratory nitrate reductase, gamma subunit (narI) [1.7.99.4]
ORF01893	3785 & 3786	Respiratory nitrate reductase 1 delta chain [1.7.99.4]
ORF01894	3787 & 3788	nitrate reductase, beta subunit (narH) [1.7.99.4]
ORF01895	3789 & 3790	nitrate reductase, alpha subunit [1.7.99.4]
ORF01896	3791 & 3792	Nitrite extrusion protein 1
ORF01897	3793 & 3794	Nitrate-nitrite sensor protein narX [2.7.3.-]
ORF01898	3795 & 3796	narL
ORF01899	3797 & 3798	conserved hypothetical protein
ORF01900	3799 & 3800	YchN protein
ORF01901	3801 & 3802	Cation transport protein chaC
ORF01902	3803 & 3804	Cation transport regulator chaB-related protein
ORF01903	3805 & 3806	Calcium-proton antiporter
ORF01904	3807 & 3808	conserved hypothetical protein
ORF01905	3809 & 3810	3-deoxy-8-phosphooctulonate synthase (kdsA) [2.5.1.55]
ORF01906	3811 & 3812	Protein sirB1
ORF01907	3813 & 3814	Protein sirB1
ORF01908	3815 & 3816	Protein sirB2
ORF01909	3817 & 3818	Protein methyltransferase hemK (hemK) [2.1.1.-]
ORF01910	3819 & 3820	peptide chain release factor 1 (prfA)
ORF01911	3821 & 3822	glutamyl-tRNA reductase (hemA) [1.2.1.-]
ORF01912	3823 & 3824	outer membrane lipoprotein LolB (lolB)
ORF01913	3825 & 3826	4-diphosphocytidyl-2C-methyl-D-erythritol kinase (ispE) [2.7.1.148]
ORF01914	3827 & 3828	Ribose-phosphate pyrophosphokinase
ORF01915	3829 & 3830	sulfate permease family protein
ORF01916	3831 & 3832	conserved hypothetical protein
ORF01917	3833 & 3834	peptidyl-tRNA hydrolase (pth) [3.1.1.29]
ORF01918	3835 & 3836	GTP-binding protein YchF (ychF)
ORF01919	3837 & 3838	Glycerol metabolism operon Regulatory protein
ORF01920	3839 & 3840	dihydroxyacetone kinase, DhaK subunit (dhaK) [2.7.1.-]

ORF01921	3841 & 3842	dihydroxyacetone kinase, L subunit [2.7.1.-]
ORF01922	3843 & 3844	phosphoenolpyruvate-protein phosphotransferase,EI-HPr-EIIA components
ORF01923	3845 & 3846	hypothetical protein
ORF01924	3847 & 3848	conserved hypothetical protein
ORF01925	3849 & 3850	Trehalase [3.2.1.28]
ORF01926	3851 & 3852	Periplasmic binding protein family
ORF01927	3853 & 3854	Iron (III)
ORF01928	3855 & 3856	conserved hypothetical protein
ORF01929	3857 & 3858	possible ABC-type iron-siderophore transport system ATP-binding protein (III)
ORF01930	3859 & 3860	conserved hypothetical protein
ORF01931	3861 & 3862	modD protein (modD)
ORF01932	3863 & 3864	Putative outer membrane receptor, probably tonB dependent
ORF01933	3865 & 3866	Transglycosylase associated protein
ORF01934	3867 & 3868	YcgR protein superfamily
ORF01935	3869 & 3870	murein transglycosylase E
ORF01936	3871 & 3872	Muramoyltetrapeptide carboxypeptidase (LD-carboxypeptidase A) [3.4.17.13]
ORF01937	3873 & 3874	Na+-H+ antiporter
ORF01938	3875 & 3876	alanine racemase (alr) [5.1.1.1]
ORF01939	3877 & 3878	D-amino acid dehydrogenase small subunit
ORF01940	3879 & 3880	unidentified protein
ORF01941	3881 & 3882	negative regulator for fad regulon, and positive
ORF01942	3883 & 3884	Na+-H+ antiporter NhaB (nhaB)
ORF01943	3885 & 3886	Disulfide bond formation protein B [1.8.4.-]
ORF01944	3887 & 3888	UmuC protein
ORF01945	3889 & 3890	UmuD protein (R391) [3.4.21.-]
ORF01946	3891 & 3892	cytolysin A
ORF01947	3893 & 3894	Bacterial protein of unknown function (DUF838) superfamily
ORF01948	3895 & 3896	Protein ycgM (FAA)
ORF01949	3897 & 3898	Protein ycgL
ORF01950	3899 & 3900	Fels-1 Prophage Protein-like family
ORF01951	3901 & 3902	septum site-determining protein MinC (minC)
ORF01952	3903 & 3904	Lom
ORF01953	3905 & 3906	Putative tail component of prophage (partial)
ORF01954	3907 & 3908	Lom
ORF01955	3909 & 3910	Putative tail component of prophage (partial)
ORF01956	3911 & 3912	hypothetical protein
ORF01957	3913 & 3914	GntR-family transcriptional regulator
ORF01958	3915 & 3916	conserved hypothetical protein
ORF01959	3917 & 3918	fructuronate reductase [1.-.-.-]
ORF01960	3919 & 3920	metabolite-proton symporter (PPII)
ORF01961	3921 & 3922	L-iditol 2-dehydrogenase
ORF01962	3923 & 3924	Starvation sensing protein rspA
ORF01963	3925 & 3926	Uncharacterized BCR, YnfA-UPF0060 family superfamily
ORF01964	3927 & 3928	Protein of unknown function (DUF1283) superfamily
ORF01965	3929 & 3930	Spermidine N(1)-acetyltransferase (SAT) [2.3.1.57]
ORF01966	3931 & 3932	ynfC protein
ORF01967	3933 & 3934	Protein of unknown function (DUF1161) family
ORF01968	3935 & 3936	DmsA [1.8.99.-]
ORF01969	3937 & 3938	DmsA [1.8.99.-]
ORF01970	3939 & 3940	dimethylsulfoxide reductase chain A2 precursor, anaerobic [1.8.-.-]
ORF01971	3941 & 3942	Anaerobic dimethyl sulfoxide reductase chain B (dmsB) [1.8.-.-]
ORF01972	3943 & 3944	DMSO reductase anchor subunit (DmsC) (dmsC) [1.8.99.-]

ORF01973	3945 & 3946	TorD protein
ORF01974	3947 & 3948	dethiobiotin synthetase (DTBS)
ORF01975	3949 & 3950	Putative chloride channel protein eriC-like
ORF01976	3951 & 3952	Mlc protein
ORF01977	3953 & 3954	transcriptional regulator, LysR family
ORF01978	3955 & 3956	unnamed protein product
ORF01979	3957 & 3958	Acid shock protein repeat family
ORF01980	3959 & 3960	glutamyl endopeptidase [3.4.21.-]
ORF01981	3961 & 3962	possible chaperone
ORF01982	3963 & 3964	DMT Superfamily drug efflux pump
ORF01983	3965 & 3966	Domain of unknown function, putative
ORF01984	3967 & 3968	NAD(P) transhydrogenase, beta subunit (pntB) [1.6.1.2]
ORF01985	3969 & 3970	NAD(P) transhydrogenase, alpha subunit (pntA) [1.6.1.1]
ORF01986	3971 & 3972	Protein ydgH precursor
ORF01987	3973 & 3974	hypothetical protein
ORF01988	3975 & 3976	unnamed protein product
ORF01989	3977 & 3978	fabG5, putative [1.-.-.-]
ORF01990	3979 & 3980	Membrane protein glpM
ORF01991	3981 & 3982	Transcriptional Regulatory protein rstA
ORF01992	3983 & 3984	Sensor protein rstB [2.7.3.-]
ORF01993	3985 & 3986	DNA replication terminus site-binding protein
ORF01994	3987 & 3988	fumarate hydratase, class II (fumC) [4.2.1.2]
ORF01995	3989 & 3990	fumarate hydratase class I, anaerobic [4.2.1.2]
ORF01996	3991 & 3992	mannose-6-phosphate isomerase, class I (manA) [5.3.1.8]
ORF01997	3993 & 3994	Bacterial protein of unknown function (DUF945) superfamily
ORF01998	3995 & 3996	membrane-associated protein
ORF01999	3997 & 3998	Glucuronide carrier protein
ORF02000	3999 & 4000	Beta-glucuronidase (GUS) [3.2.1.31]
ORF02001	4001 & 4002	transcriptional regulator, TetR family domain protein, putative
ORF02002	4003 & 4004	7-alpha-hydroxysteroid dehydrogenase
ORF02003	4005 & 4006	Maltose regulon Regulatory protein malI
ORF02004	4007 & 4008	PTS system, maltose and glucose-specific IIBC component (malX) [2.7.1.69]
ORF02005	4009 & 4010	aminotransferase, class II, putative [4.4.1.8]
ORF02006	4011 & 4012	adenosine deaminase (add) [3.5.4.4]
ORF02007	4013 & 4014	predicted dehydrogenase
ORF02008	4015 & 4016	Hha protein
ORF02009	4017 & 4018	conserved hypothetical protein
ORF02010	4019 & 4020	Electron transport complex protein rnfA
ORF02011	4021 & 4022	Electron transport complex protein rnfB
ORF02012	4023 & 4024	Electron transport complex protein rnfC
ORF02013	4025 & 4026	Electron transport complex protein rnfD
ORF02014	4027 & 4028	Electron transport complex protein rnfG (rnfG)
ORF02015	4029 & 4030	Electron transport complex protein rnfE
ORF02016	4031 & 4032	endonuclease III (nth) [4.2.99.18]
ORF02017	4033 & 4034	Hypothetical transporter ydgR
ORF02018	4035 & 4036	Glutathione S-transferase [2.5.1.18]
ORF02019	4037 & 4038	pyridoxal kinase [2.7.1.35]
ORF02020	4039 & 4040	tyrosyl-tRNA synthetase (tyrS) [6.1.1.1]
ORF02021	4041 & 4042	pyridoxamine 5'-phosphate oxidase (pdxH) [1.4.3.5]
ORF02022	4043 & 4044	ydhA protein
ORF02023	4045 & 4046	Hypothetical UPF0075 protein ydhH
ORF02024	4047 & 4048	SlyA

ORF02025	4049 & 4050	Fusaric acid resistance protein FusE.
ORF02026	4051 & 4052	Fusaric acid resistance protein conserved region family
ORF02027	4053 & 4054	Copper-zinc superoxide dismutase (sodC)
ORF02028	4055 & 4056	oxidoreductase, aldo-keto reductase family [1.-.-.-]
ORF02029	4057 & 4058	unnamed protein product
ORF02030	4059 & 4060	transcriptional regulatory protein
ORF02031	4061 & 4062	N-ethylmaleimide reductase (Y13942) [1.-.-.-]
ORF02032	4063 & 4064	lactoylglutathione lyase (gloA) [4.4.1.5]
ORF02033	4065 & 4066	ribonuclease T (rnt) [3.1.13.-]
ORF02034	4067 & 4068	glutaredoxin-related protein
ORF02035	4069 & 4070	hypothetical protein
ORF02036	4071 & 4072	putative lipoprotein
ORF02037	4073 & 4074	superoxide dismutase, iron [1.15.1.1]
ORF02038	4075 & 4076	major facilitator family transporter (AL136500)
ORF02039	4077 & 4078	hypothetical protein
ORF02040	4079 & 4080	Purine nucleotide synthesis repressor (purR)
ORF02041	4081 & 4082	cyn operon transcriptional activator.
ORF02042	4083 & 4084	Bicyclomycin resistance protein (Sulfonamide resistance protein).
ORF02043	4085 & 4086	cyclopropane-fatty-acyl-phospholipid synthase [2.1.1.79]
ORF02044	4087 & 4088	riboflavin synthase, alpha subunit (ribE) [2.5.1.9]
ORF02045	4089 & 4090	Multidrug resistance protein norM
ORF02046	4091 & 4092	possible enzyme
ORF02047	4093 & 4094	Protein ydhR precursor
ORF02048	4095 & 4096	conserved hypothetical protein
ORF02049	4097 & 4098	conserved hypothetical protein
ORF02050	4099 & 4100	PhsC protein homolog [2.8.1.5]
ORF02051	4101 & 4102	nrfC protein homolog b1671 (nrfC) [2.8.1.5]
ORF02052	4103 & 4104	conserved hypothetical protein
ORF02053	4105 & 4106	aldehyde-ferredoxin oxidoreductase PH0892 (aor) [1.-.-.-]
ORF02054	4107 & 4108	aldehyde oxidoreductase (aor) [1.-.-.-]
ORF02055	4109 & 4110	iron-sulfur cluster-binding protein [2.8.1.5]
ORF02056	4111 & 4112	conserved hypothetical protein
ORF02057	4113 & 4114	pyruvate kinase (pyk) [2.7.1.40]
ORF02058	4115 & 4116	major outer membrane lipoprotein
ORF02059	4117 & 4118	ErfK-YbiS-YcfS-YnhG family
ORF02060	4119 & 4120	SufE protein (orf5)
ORF02061	4121 & 4122	aminotransferase, class-V [4.4.1.16]
ORF02062	4123 & 4124	FeS assembly protein SufD (sufD)
ORF02063	4125 & 4126	FeS assembly ATPase SufC (sufC)
ORF02064	4127 & 4128	FeS assembly protein SufB (sufB)
ORF02065	4129 & 4130	FeS assembly scaffold SufA (sufA)
ORF02066	4131 & 4132	unnamed protein product
ORF02067	4133 & 4134	uncharacterized domain 1, putative
ORF02068	4135 & 4136	oxidoreductase, FAD-binding, putative
ORF02069	4137 & 4138	Hypothetical UPF0118 protein ydiK
ORF02070	4139 & 4140	conserved hypothetical protein
ORF02071	4141 & 4142	transport system permease protein homolog lin2340
ORF02072	4143 & 4144	Hypothetical transport protein ydiN
ORF02073	4145 & 4146	shikimate 5-dehydrogenase [1.1.1.-]
ORF02074	4147 & 4148	3-dehydroquinate dehydratase, type I (aroD) [4.2.1.10]
ORF02075	4149 & 4150	acetyl-CoA-transferase subunit, putative [2.8.3.-]
ORF02076	4151 & 4152	acyl-CoA dehydrogenase family protein, putative [1.3.99.-]

ORF02077	4153 & 4154	Hypothetical transcriptional regulator ydiP
ORF02078	4155 & 4156	FixA protein
ORF02079	4157 & 4158	electron transfer flavoprotein, alpha subunit, putative
ORF02080	4159 & 4160	flavoprotein, probably electron transport [1.5.5.-]
ORF02081	4161 & 4162	Ferredoxin-like protein ydiT
ORF02082	4163 & 4164	substrate--CoA ligase, putative [6.2.1.-]
ORF02083	4165 & 4166	phosphoenolpyruvate synthase (ppsA) [2.7.9.2]
ORF02084	4167 & 4168	Hypothetical UPF0085 protein ydiA
ORF02085	4169 & 4170	phospho-2-dehydro-3-deoxyheptonate aldolase [2.5.1.54]
ORF02086	4171 & 4172	conserved hypothetical protein
ORF02087	4173 & 4174	Hypothetical UPF0061 protein ydiU (AP001520)
ORF02088	4175 & 4176	conserved hypothetical protein
ORF02089	4177 & 4178	lipoprotein (ORF)
ORF02090	4179 & 4180	Vitamin B12 transport ATP-binding protein btuD (VitaminB12-transporting ATPase) [3.6.3.33]
ORF02091	4181 & 4182	Glutathione peroxidase
ORF02092	4183 & 4184	Vitamin B12 transport system permease protein btuC (membrane)
ORF02093	4185 & 4186	integration host factor, alpha subunit (ihfA)
ORF02094	4187 & 4188	phenylalanyl-tRNA synthetase, beta subunit (pheT) [6.1.1.20]
ORF02095	4189 & 4190	phenylalanyl-tRNA synthetase, alpha subunit (pheS) [6.1.1.20]
ORF02096	4191 & 4192	ribosomal protein L20 (rplT)
ORF02097	4193 & 4194	ribosomal protein L35 (rpmI)
ORF02098	4195 & 4196	translation initiation factor IF-3 (infC)
ORF02099	4197 & 4198	threonyl-tRNA synthetase (thrS) [6.1.1.3]
ORF02100	4199 & 4200	InsAB' protein
ORF02101	4201 & 4202	InsA protein
ORF02102	4203 & 4204	hypothetical protein
ORF02103	4205 & 4206	Protein of unknown function, DUF481 superfamily
ORF02104	4207 & 4208	pfkB (pfkB) [2.7.1.11]
ORF02105	4209 & 4210	conserved hypothetical protein
ORF02106	4211 & 4212	Fructosamine kinase subfamily
ORF02107	4213 & 4214	conserved hypothetical protein
ORF02108	4215 & 4216	Protein yniC (YniC) [3.1.3.18]
ORF02109	4217 & 4218	Predicted membrane-bound metal-dependent hydrolase (DUF457) family
ORF02110	4219 & 4220	sodium:dicarboxylate symporter family protein
ORF02111	4221 & 4222	Cell division activator cedA
ORF02112	4223 & 4224	conserved hypothetical protein
ORF02113	4225 & 4226	Catalase HPII (III) [1.11.1.6]
ORF02114	4227 & 4228	unnamed protein product; ORF 28.5
ORF02115	4229 & 4230	6-phospho-beta-glucosidase [3.2.1.86]
ORF02116	4231 & 4232	Cel operon repressor
ORF02117	4233 & 4234	PEP-dependent phosphotransferase enzyme III for cellobiose, arbutin, and salicin (PTS) [2.7.1.69]
ORF02118	4235 & 4236	PTS system, cellobiose-specific IIC component (celB)
ORF02119	4237 & 4238	PTS system, N,N'-diacetylchitobiose-specific IIB component (EIIB-Chb)(N,N'-diacetylchitobiose-permease IIB component) (Phosphotransferaseenzyme II, B component) [2.7.1.69]
ORF02120	4239 & 4240	Osmotically inducible lipoprotein E precursor
ORF02121	4241 & 4242	NAD+ synthetase (nadE) [6.3.1.5]
ORF02122	4243 & 4244	Bacterial protein of unknown function (DUF886) superfamily
ORF02123	4245 & 4246	excinuclease ABC subunit C homolog
ORF02124	4247 & 4248	Spheroplast protein Y precursor

ORF02125	4249 & 4250	conserved hypothetical protein
ORF02126	4251 & 4252	Succinylglutamate desuccinylase [3.1.-.-]
ORF02127	4253 & 4254	Succinylarginine dihydrolase (astB)
ORF02128	4255 & 4256	Succinate semialdehyde dehydrogenase (EC 1.2.1.24) (NAD(+)-dependent succinic semialdehyde dehydrogenase). (retinol) [1.2.1.24]
ORF02129	4257 & 4258	Arginine N-succinyltransferase beta subunit (astA) [2.3.1.109]
ORF02130	4259 & 4260	Succinylornithine transaminase (Succinylornithineaminotransferase) (ACOAT) [2.6.1.-]
ORF02131	4261 & 4262	exodeoxyribonuclease III (xth) [3.1.11.2]
ORF02132	4263 & 4264	membrane protein, probable , putative
ORF02133	4265 & 4266	conserved hypothetical protein
ORF02134	4267 & 4268	DedA family family
ORF02135	4269 & 4270	IS110 family transposase, truncation, putative
ORF02136	4271 & 4272	Protein ynjB
ORF02137	4273 & 4274	Hypothetical ABC transporter permease protein ynjC
ORF02138	4275 & 4276	Inner membrane protein MalK (P-loop)
ORF02139	4277 & 4278	2.8.1.1 [2.8.1.1]
ORF02140	4279 & 4280	phosphatidylglycerophosphate synthase
ORF02141	4281 & 4282	Protein of unknown function (DUF1496) superfamily
ORF02142	4283 & 4284	mutT2 [3.6.1.-]
ORF02143	4285 & 4286	NADP-specific glutamate dehydrogenase (NADP-GDH) [1.4.1.4]
ORF02144	4287 & 4288	DNA topoisomerase III
ORF02145	4289 & 4290	selenide, water dikinase (selD) [2.7.9.3]
ORF02146	4291 & 4292	Protein ydjA
ORF02147	4293 & 4294	hypothetical protein
ORF02148	4295 & 4296	signal peptide peptidase SppA, 67K type (sppA) [3.4.-.-]
ORF02149	4297 & 4298	L-asparaginase (ansA) [3.5.1.1]
ORF02150	4299 & 4300	Pyrazinamidase-nicotinamidase (PZASE) [3.5.1.-]
ORF02151	4301 & 4302	putative transport protein
ORF02152	4303 & 4304	similar to transcription regulator DeoR family
ORF02153	4305 & 4306	aldo-keto reductase Atu3877 (gsp69) [1.-.-.-]
ORF02154	4307 & 4308	putative kinase
ORF02155	4309 & 4310	Fructose-tagatose bisphosphate aldolase [4.1.2.-]
ORF02156	4311 & 4312	Sorbitol dehydrogenase (EC 1.1.1.14) (L-iditol 2-dehydrogenase). (sorbitol) [1.1.1.14]
ORF02157	4313 & 4314	Membrane transporter D1.
ORF02158	4315 & 4316	sorbitol dehydrogenase, putative [1.1.1.-]
ORF02159	4317 & 4318	Protein of unknown function (DUF1315) superfamily
ORF02160	4319 & 4320	methionine-R-sulfoxide reductase (msrB) [1.8.4.6]
ORF02161	4321 & 4322	glyceraldehyde-3-phosphate dehydrogenase, type I (gap) [1.2.1.-]
ORF02162	4323 & 4324	transglycolase (fragment)
ORF02163	4325 & 4326	Morphine 6-dehydrogenase (EC 1.1.1.218) (Naloxone reductase). (PA0804) [1.1.1.-]
ORF02164	4327 & 4328	MltA-interacting protein precursor
ORF02165	4329 & 4330	hypothetical protein
ORF02166	4331 & 4332	protein kinase
ORF02167	4333 & 4334	Hypothetical UPF0229 protein yeaH
ORF02168	4335 & 4336	GGDEF domain protein
ORF02169	4337 & 4338	GGDEF domain protein
ORF02170	4339 & 4340	unnamed protein product
ORF02171	4341 & 4342	transcriptional regulator araC family
ORF02172	4343 & 4344	Protein of unknown function (DUF441) superfamily

ORF02173	4345 & 4346	cyanate MFS transporter (permease)
ORF02174	4347 & 4348	Protein of unknown function, DUF488 superfamily
ORF02175	4349 & 4350	hemolysin VCA0594
ORF02176	4351 & 4352	GGDEF domain protein
ORF02177	4353 & 4354	hypothetical protein
ORF02178	4355 & 4356	Transglycosylase associated protein
ORF02179	4357 & 4358	conserved hypothetical protein
ORF02180	4359 & 4360	tellurite resistance protein TehB, putative
ORF02181	4361 & 4362	hypothetical protein
ORF02182	4363 & 4364	translocator protein, LysE family superfamily
ORF02183	4365 & 4366	conserved hypothetical protein
ORF02184	4367 & 4368	tartrate dehydrogenase (3-IPM-DH) [1.1.1.93]
ORF02185	4369 & 4370	ribonuclease D (rnd) [3.1.26.3]
ORF02186	4371 & 4372	Long-chain-fatty-acid--CoA ligase
ORF02187	4373 & 4374	outer membrane lipoprotein
ORF02188	4375 & 4376	Hypothetical M22 peptidase homolog yeaZ [3.4.24.57]
ORF02189	4377 & 4378	unnamed protein product
ORF02190	4379 & 4380	Endoribonuclease L-PSP superfamily
ORF02191	4381 & 4382	conserved hypothetical protein
ORF02192	4383 & 4384	Hypothetical UPF0181 protein yoaH-related protein
ORF02193	4385 & 4386	Para-aminobenzoate synthase component I [6.3.5.8]
ORF02194	4387 & 4388	MutT-family protein
ORF02195	4389 & 4390	L-serine ammonia-lyase (sdaA) [4.3.1.17]
ORF02196	4391 & 4392	EAL domain protein
ORF02197	4393 & 4394	possible CorC-HlyC family of Mg+2-Co+2-heavy metal efflux pumps
ORF02198	4395 & 4396	PTS enzyme IIAB, mannose-specific (EIII-MAN)
ORF02199	4397 & 4398	PTS system, mannose-specific IIC component
ORF02200	4399 & 4400	PTS system, mannose-specific IID component
ORF02201	4401 & 4402	Hypothetical UPF0266 protein yobD
ORF02202	4403 & 4404	Domain of unknown function DUF family
ORF02203	4405 & 4406	23S rRNA m1G745 methyltransferase , putative [2.1.1.51]
ORF02204	4407 & 4408	Cold shock-like protein cspE
ORF02205	4409 & 4410	conserved hypothetical protein
ORF02206	4411 & 4412	lipoprotein, putative
ORF02207	4413 & 4414	conserved hypothetical protein
ORF02208	4415 & 4416	Transcriptional regulator kdgR
ORF02209	4417 & 4418	MULTIDRUG RESISTANCE PROTEIN B
ORF02210	4419 & 4420	heat shock protein, integral membrane protein (htpX) [3.4.24.-]
ORF02211	4421 & 4422	Tail-specific protease precursor [3.4.21.102]
ORF02212	4423 & 4424	carboxy-terminal protease for penicillin-binding protein 3
ORF02213	4425 & 4426	ProP effector
ORF02214	4427 & 4428	GAF domain protein
ORF02215	4429 & 4430	PqiA protein
ORF02216	4431 & 4432	PqiA protein
ORF02217	4433 & 4434	mce related protein family
ORF02218	4435 & 4436	Sun-nucleolar protein family protein
ORF02219	4437 & 4438	Protein of unknown function (DUF1480) superfamily
ORF02220	4439 & 4440	Protein of unknown function (DUF1482) family
ORF02221	4441 & 4442	Serine-threonine protein phosphatase 1
ORF02222	4443 & 4444	conserved hypothetical protein
ORF02223	4445 & 4446	unnamed protein product

ORF02224	4447 & 4448	Copper resistance protein D family, putative
ORF02225	4449 & 4450	Protein yobA precursor
ORF02226	4451 & 4452	DNA polymerase III, theta subunit [2.7.7.7]
ORF02227	4453 & 4454	hydrolase, carbon-nitrogen family family
ORF02228	4455 & 4456	DNA polymerase III, alpha subunit, Gram-positive type, putative
ORF02229	4457 & 4458	protease II (AB004795) [3.4.21.83]
ORF02230	4459 & 4460	unidentified reading frame
ORF02231	4461 & 4462	unnamed protein product; Similar to lipoprotein YebF precursor of Escherichia coli
ORF02232	4463 & 4464	hypothetical protein
ORF02233	4465 & 4466	DNA damage-inducible gene in SOS regulon, dependent on cyclic AMP and H-NS
ORF02234	4467 & 4468	phosphoribosylglycinamide formyltransferase 2 (purT) [2.1.2.-]
ORF02235	4469 & 4470	2-deydro-3-deoxyphosphogluconate aldolase-4-hydroxy-2-oxoglutarate aldolase (eda) [4.1.3.16]
ORF02236	4471 & 4472	phosphogluconate dehydratase (edd) [4.2.1.12]
ORF02237	4473 & 4474	glucose-6-phosphate 1-dehydrogenase (zwf) [1.1.1.49]
ORF02238	4475 & 4476	conserved hypothetical protein
ORF02239	4477 & 4478	Hex regulon repressor
ORF02240	4479 & 4480	pyruvate kinase (pyk) [2.7.1.40]
ORF02241	4481 & 4482	lipid A biosynthesis (KDO)2-(lauroyl)-lipid IVA acyltransferase (msbB) [2.3.1.-]
ORF02242	4483 & 4484	Cell envelope
ORF02243	4485 & 4486	High-affinity zinc uptake system protein znuA precursor (AE005408)
ORF02244	4487 & 4488	ABC superfamily high affinity Zn transport protein (atp_bind)
ORF02245	4489 & 4490	High-affinity zinc uptake system membrane protein znuB (atp_bind)
ORF02246	4491 & 4492	Holliday junction DNA helicase RuvB (ruvB)
ORF02247	4493 & 4494	Holliday junction DNA helicase RuvA (ruvA)
ORF02248	4495 & 4496	Protein of unknown function (DUF1105) superfamily
ORF02249	4497 & 4498	crossover junction endodeoxyribonuclease RuvC (ruvC) [3.1.22.4]
ORF02250	4499 & 4500	conserved hypothetical protein TIGR01033
ORF02251	4501 & 4502	dATP pyrophosphohydrolase
ORF02252	4503 & 4504	aspartyl-tRNA synthetase (aspS) [6.1.1.12]
ORF02253	4505 & 4506	Hypothetical isochorismatase family protein yecD
ORF02254	4507 & 4508	Protein of unknown function superfamily
ORF02255	4509 & 4510	conserved hypothetical protein
ORF02256	4511 & 4512	methyltransferase, putative
ORF02257	4513 & 4514	methyltransferase, putative
ORF02258	4515 & 4516	Trimethylamine-N-oxide reductase 2 precursor
ORF02259	4517 & 4518	Cytochrome c-type protein torY
ORF02260	4519 & 4520	copper homeostasis protein VC0730
ORF02261	4521 & 4522	Protein yecM
ORF02262	4523 & 4524	arginyl-tRNA synthetase (argS) [6.1.1.19]
ORF02263	4525 & 4526	Flagellar protein flhE precursor
ORF02264	4527 & 4528	flagellar biosynthesis protein FlhA (flhA)
ORF02265	4529 & 4530	flagellar biosynthetic protein FlhB (flhB)
ORF02266	4531 & 4532	conserved hypothetical protein
ORF02267	4533 & 4534	Chemotaxis protein cheZ
ORF02268	4535 & 4536	Chemotaxis protein cheY
ORF02269	4537 & 4538	Chemotaxis response regulator protein-glutamate methylesterase(EC 3.1.1.61) [3.1.1.61]
ORF02270	4539 & 4540	Chemotaxis protein methyltransferase [2.1.1.80]
ORF02271	4541 & 4542	methyl-accepting chemotaxis protein IV, peptide sensor receptor
ORF02272	4543 & 4544	conserved hypothetical protein
ORF02273	4545 & 4546	Methyl-accepting chemotaxis protein II

ORF02274	4547 & 4548	Chemotaxis protein cheW
ORF02275	4549 & 4550	Chemotaxis protein cheA
ORF02276	4551 & 4552	Chemotaxis motB protein
ORF02277	4553 & 4554	Chemotaxis motA protein
ORF02278	4555 & 4556	Flagellar transcriptional activator flhC
ORF02279	4557 & 4558	regulator of flagellar biosynthesis, acting on class 2 operons; transcriptional initiation factor
ORF02280	4559 & 4560	Universal stress protein C (UspA)
ORF02281	4561 & 4562	alpha,alpha-trehalose-phosphate synthase [UDP-forming] (otsA) [2.4.1.15]
ORF02282	4563 & 4564	trehalose-phosphatase (otsB) [3.1.3.12]
ORF02283	4565 & 4566	L-arabinose transport system permease protein araH
ORF02284	4567 & 4568	L-arabinose transport ATP-binding protein araG
ORF02285	4569 & 4570	L-arabinose-binding periplasmic protein precursor (PBP)
ORF02286	4571 & 4572	Ferritin-like protein 2
ORF02287	4573 & 4574	conserved hypothetical protein
ORF02288	4575 & 4576	lipoprotein, putative
ORF02289	4577 & 4578	conserved hypothetical protein
ORF02290	4579 & 4580	cytoplasmic ferritin (an iron storage protein)
ORF02291	4581 & 4582	conserved hypothetical protein
ORF02292	4583 & 4584	Tyrosine-specific transport protein
ORF02293	4585 & 4586	preprotein translocase, SecA subunit
ORF02294	4587 & 4588	conserved hypothetical protein
ORF02295	4589 & 4590	Fels-2 prophage: similar to retron in E
ORF02296	4591 & 4592	ParA
ORF02297	4593 & 4594	Sb32
ORF02298	4595 & 4596	hypothetical protein
ORF02299	4597 & 4598	phage portal protein, PBSX family
ORF02300	4599 & 4600	Putative ATPase subunit of terminase (gpP-like)
ORF02301	4601 & 4602	Phage capsid scaffolding protein (GPO)
ORF02302	4603 & 4604	phage major capsid protein, P2 family
ORF02303	4605 & 4606	Phage small terminase subunit
ORF02304	4607 & 4608	head completion-stabilization protein L
ORF02305	4609 & 4610	Phage Tail Protein X
ORF02306	4611 & 4612	Bbp2
ORF02307	4613 & 4614	conserved hypothetical protein
ORF02308	4615 & 4616	phage tail completion protein R
ORF02309	4617 & 4618	Fels-2 prophage: similar to gpS for completion
ORF02310	4619 & 4620	baseplate assembly protein V (gpV)
ORF02311	4621 & 4622	phage baseplate assembly protein W (gpW)
ORF02312	4623 & 4624	Baseplate J-like protein
ORF02313	4625 & 4626	gpI (gpI)
ORF02314	4627 & 4628	gpH (gpH)
ORF02315	4629 & 4630	gpU prime (gpG)
ORF02316	4631 & 4632	CDP-diacylglycerol--glycerol-3-phosphate 3-phosphatidyltransferase (pgsA) [2.7.8.5]
ORF02317	4633 & 4634	excinuclease ABC, C subunit (uvrC)
ORF02318	4635 & 4636	response regulator protein
ORF02319	4637 & 4638	conserved hypothetical protein
ORF02320	4639 & 4640	Regulatory protein sdiA
ORF02321	4641 & 4642	amino acid ABC transporter, ATP-binding protein
ORF02322	4643 & 4644	amino acid ABC transporter, permease protein (permease)
ORF02323	4645 & 4646	4.4.1.15 [3.5.99.7]

ORF02324	4647 & 4648	Cystine-binding periplasmic protein precursor
ORF02325	4649 & 4650	FliZ protein
ORF02326	4651 & 4652	transcription initiation factor alternative sigma factor 28 (Sigma)
ORF02327	4653 & 4654	FliC
ORF02328	4655 & 4656	Flagellar hook-associated protein 2 (HAP2)
ORF02329	4657 & 4658	flagellar protein FliS (fliS)
ORF02330	4659 & 4660	flagellar protein FliT
ORF02331	4661 & 4662	Cytoplasmic alpha-amylase [3.2.1.1]
ORF02332	4663 & 4664	Hypothetical lipoprotein yedD precursor
ORF02333	4665 & 4666	YeeE-YedE family protein family
ORF02334	4667 & 4668	Hypothetical UPF0033 protein yedF-related protein
ORF02335	4669 & 4670	Uncharacterized ACR, COG2135 superfamily
ORF02336	4671 & 4672	Outer membrane porin protein nmpC precursor
ORF02337	4673 & 4674	Hypothetical transcriptional regulator ybcM
ORF02338	4675 & 4676	conserved hypothetical protein
ORF02339	4677 & 4678	EmrE protein
ORF02340	4679 & 4680	flagellar hook-basal body complex protein (FliE) (fliE)
ORF02341	4681 & 4682	flagellar M-ring protein FliF (fliF)
ORF02342	4683 & 4684	flagellar motor switch protein FliG (fliG)
ORF02343	4685 & 4686	Flagellar assembly protein FliH (fliH)
ORF02344	4687 & 4688	flagellum-specific ATP synthase
ORF02345	4689 & 4690	flagellar export protein FliJ (fliJ)
ORF02346	4691 & 4692	flagellar hook-length control protein
ORF02347	4693 & 4694	Flagellar basal body-associated protein FliL (fliL)
ORF02348	4695 & 4696	flagellar motor switch protein FliM (fliM)
ORF02349	4697 & 4698	Flagellar motor switch protein fliN
ORF02350	4699 & 4700	Flagellar protein fliO
ORF02351	4701 & 4702	Unknown protein encoded by cryptic prophage
ORF02352	4703 & 4704	Helix-turn-helix domain protein
ORF02353	4705 & 4706	stability determinant
ORF02354	4707 & 4708	unknown protein encoded by prophage CP-933N -related protein
ORF02355	4709 & 4710	Division inhibition protein dicB
ORF02356	4711 & 4712	conserved hypothetical protein
ORF02357	4713 & 4714	Exodeoxyribonuclease VIII (35kD) [3.1.11.-]
ORF02358	4715 & 4716	conserved hypothetical protein
ORF02359	4717 & 4718	Sb28 (AE005423)
ORF02360	4719 & 4720	Protein of unknown function (DUF980) superfamily
ORF02361	4721 & 4722	hypothetical protein
ORF02362	4723 & 4724	integrase
ORF02363	4725 & 4726	trpE2
ORF02364	4727 & 4728	Putative cytoplasmic transmembrane protein
ORF02365	4729 & 4730	ABC transporter, ATP-binding-permease protein, putative
ORF02366	4731 & 4732	EF0101
ORF02367	4733 & 4734	hypothetical protein
ORF02368	4735 & 4736	Putataive AraC type regulator
ORF02369	4737 & 4738	dihydroaeruginoic acid synthetase
ORF02370	4739 & 4740	yersiniabactin biosynthetic protein
ORF02371	4741 & 4742	yersiniabactin biosynthetic protein YbtU
ORF02372	4743 & 4744	yersiniabactin biosynthetic protein YbtT
ORF02373	4745 & 4746	mbtA [6.2.1.-]
ORF02374	4747 & 4748	OMR family pesticin-yersiniabactin receptor protein (IRPC)
ORF02375	4749 & 4750	conserved hypothetical protein

ORF02376	4751 & 4752	putative factor
ORF02377	4753 & 4754	putative factor
ORF02378	4755 & 4756	conserved hypothetical protein
ORF02379	4757 & 4758	major facilitator family transporter (PPII)
ORF02380	4759 & 4760	AMP nucleosidase (amn) [3.2.2.4]
ORF02381	4761 & 4762	Domain of unknown function, putative
ORF02382	4763 & 4764	MelD protein
ORF02383	4765 & 4766	amidase family protein, putative
ORF02384	4767 & 4768	MATE efflux family protein subfamily
ORF02385	4769 & 4770	Putative peptide synthetase
ORF02386	4771 & 4772	NosB (AF183408)
ORF02387	4773 & 4774	fmtA-like protein, putative
ORF02388	4775 & 4776	thioesterase
ORF02389	4777 & 4778	Prophage P4 integrase
ORF02390	4779 & 4780	hypothetical protein
ORF02391	4781 & 4782	MATE efflux family protein subfamily
ORF02392	4783 & 4784	TubD protein [6.3.2.-]
ORF02393	4785 & 4786	BarG
ORF02394	4787 & 4788	NosB
ORF02395	4789 & 4790	AMP-binding enzyme domain protein
ORF02396	4791 & 4792	[acyl-carrier-protein] S-malonyltransferase [2.3.1.39]
ORF02397	4793 & 4794	Putative acyl-coa dehydrogenase
ORF02398	4795 & 4796	acyl carrier protein
ORF02399	4797 & 4798	3-hydroxyacyl CoA dehydrogenase (BHBD) [1.1.1.157]
ORF02400	4799 & 4800	JamP
ORF02401	4801 & 4802	oxidoreductase, zinc-binding dehydrogenase family family
ORF02402	4803 & 4804	possible DNA-binding response regulator
ORF02403	4805 & 4806	EntD-Gsp-HetI-Sfp family protein [2.7.8.-]
ORF02404	4807 & 4808	transposase
ORF02405	4809 & 4810	ISSo2, transposase OrfB, truncation
ORF02406	4811 & 4812	Protein erfK-srfK precursor
ORF02407	4813 & 4814	Nicotinate-nucleotide--dimethylbenzimidazole phosphoribosyltransferase(EC 2.4.2.21) (NN:DBI PRT) (N(1)-alpha-phosphoribosyltransferase) [2.4.2.21]
ORF02408	4815 & 4816	cobalamin 5'-phosphate synthase (cobS) [2.7.8.26]
ORF02409	4817 & 4818	Cobalamin biosynthesis protein cobU [2.7.1.156]
ORF02410	4819 & 4820	conserved hypothetical protein
ORF02411	4821 & 4822	conserved hypothetical protein
ORF02412	4823 & 4824	TonB dependent receptor, putative
ORF02413	4825 & 4826	conserved hypothetical protein
ORF02414	4827 & 4828	Z1204 protein
ORF02415	4829 & 4830	conserved hypothetical protein
ORF02416	4831 & 4832	glucosaminyltransferase
ORF02417	4833 & 4834	Sugar phosphate nucleotydyl transferase
ORF02418	4835 & 4836	conserved hypothetical protein
ORF02419	4837 & 4838	host specificity protein J, truncation, putative
ORF02420	4839 & 4840	host specificity protein (partial)
ORF02421	4841 & 4842	host specificity protein (partial)
ORF02422	4843 & 4844	Terminase small subunit (GP1) (fragment)
ORF02423	4845 & 4846	conserved hypothetical protein
ORF02424	4847 & 4848	Partial tonB-like membrane protein encoded within prophage
ORF02425	4849 & 4850	hypothetical protein
ORF02426	4851 & 4852	Bor protein homolog from lambdoid prophage DLP12

ORF02427	4853 & 4854	Bacteriophage lysis protein
ORF02428	4855 & 4856	lipoprotein Rz1 precursor -related protein
ORF02429	4857 & 4858	hypothetical protein
ORF02430	4859 & 4860	Lysozyme (Lysis protein) (Muramidase) (Endolysin) (lysozyme) [3.2.1.17]
ORF02431	4861 & 4862	lysis protein S.b1556
ORF02432	4863 & 4864	hypothetical protein
ORF02433	4865 & 4866	Outer membrane porin protein nmpC precursor (Ibc)
ORF02434	4867 & 4868	Antitermination protein Q homolog from lambdoid prophage
ORF02435	4869 & 4870	endodeoxyribonuclease RUS (Holliday junction resolvase)
ORF02436	4871 & 4872	Protein ninE-related protein
ORF02437	4873 & 4874	phage N-6-adenine-methyltransferase [2.1.1.72]
ORF02438	4875 & 4876	Protein ninB
ORF02439	4877 & 4878	replication protein P
ORF02440	4879 & 4880	transposase
ORF02441	4881 & 4882	ECs1339
ORF02442	4883 & 4884	ribokinase
ORF02443	4885 & 4886	Protein of unknown function (DUF1355) superfamily
ORF02444	4887 & 4888	membrane protein, putative
ORF02445	4889 & 4890	puative phophotriesterase (PTE) [3.1.8.1]
ORF02446	4891 & 4892	gamma-glutamyltranspeptidase
ORF02447	4893 & 4894	gamma-glutamyltranspeptidase
ORF02448	4895 & 4896	ST55 protein
ORF02449	4897 & 4898	conserved hypothetical protein
ORF02450	4899 & 4900	conserved hypothetical protein
ORF02451	4901 & 4902	ISBma3, transposase, truncation
ORF02452	4903 & 4904	Prophage CP4-57 regulatory protein (AlpA) family
ORF02453	4905 & 4906	hypothetical protein
ORF02454	4907 & 4908	conserved hypothetical protein
ORF02455	4909 & 4910	hypothetical protein
ORF02456	4911 & 4912	Insertion sequence ATP-binding protein
ORF02457	4913 & 4914	Transposase
ORF02458	4915 & 4916	conserved hypothetical protein
ORF02459	4917 & 4918	ferric-enterobactin-transport protein (III)
ORF02460	4919 & 4920	ABC transporter permease STY0802 (FecCD_family)
ORF02461	4921 & 4922	Periplasmic binding protein (III)
ORF02462	4923 & 4924	TonB dependent receptor
ORF02463	4925 & 4926	YeeP protein
ORF02464	4927 & 4928	conserved hypothetical protein
ORF02465	4929 & 4930	conserved hypothetical protein
ORF02466	4931 & 4932	conserved hypothetical protein
ORF02467	4933 & 4934	Patatin-like phospholipase family
ORF02468	4935 & 4936	conserved hypothetical protein
ORF02469	4937 & 4938	conserved hypothetical protein
ORF02470	4939 & 4940	conserved hypothetical protein
ORF02471	4941 & 4942	Z1215 protein (o273)
ORF02472	4943 & 4944	Antirestriction protein family
ORF02473	4945 & 4946	YeeS protein (o160)
ORF02474	4947 & 4948	Protein of unknown function (DUF987) superfamily
ORF02475	4949 & 4950	YeeU protein
ORF02476	4951 & 4952	L0007-like protein
ORF02477	4953 & 4954	YeeW protein

ORF02478	4955 & 4956	Protein of unknown function (DUF496) superfamily
ORF02479	4957 & 4958	conserved hypothetical protein
ORF02480	4959 & 4960	DNA gyrase inhibitory protein
ORF02481	4961 & 4962	Penicillin-binding protein 6B precursor (PBP)
ORF02482	4963 & 4964	penicillin binding protein 6b
ORF02483	4965 & 4966	Exodeoxyribonuclease I
ORF02484	4967 & 4968	amino acid permease
ORF02485	4969 & 4970	transcriptional regulator, LysR family
ORF02486	4971 & 4972	Protein yeeZ precursor
ORF02487	4973 & 4974	addiction module toxin, Txe-YoeB family
ORF02488	4975 & 4976	yefM protein
ORF02489	4977 & 4978	ATP phosphoribosyltransferase (hisG) [2.4.2.17]
ORF02490	4979 & 4980	histidinol dehydrogenase (hisD) [1.1.1.23]
ORF02491	4981 & 4982	histidinol-phosphate aminotransferase (hisC) [2.6.1.9]
ORF02492	4983 & 4984	Histidine biosynthesis bifunctional protein hisB
ORF02493	4985 & 4986	Imidazole glycerol phosphate synthase subunit hisH (IGPsynthase glutamine amidotransferase subunit) (IGP synthase subunithisH) (ImGP synthase subunit hisH) (IGPS subunit hisH) [2.4.2.-]
ORF02494	4987 & 4988	imidazole glycerol phosphate synthase, glutamine amidotransferase subunit (hisH) [2.4.2.-]
ORF02495	4989 & 4990	phosphoribosylformimino-5-aminoimidazole carboxamide ribotide isomerase (hisA) [5.3.1.16]
ORF02496	4991 & 4992	imidazoleglycerol phosphate synthase, cyclase subunit (hisF)
ORF02497	4993 & 4994	Histidine biosynthesis bifunctional protein hisIE [Includes:Phosphoribosyl-AMP cyclohydrolase (PRA-CH);Phosphoribosyl-ATP pyrophosphatase (EC 3.6.1.31) (PRA-PH)] (PRA-PH) [3.5.4.19]
ORF02498	4995 & 4996	Chain length determinant protein
ORF02499	4997 & 4998	UDP-glucose 6-dehydrogenase (UDPGDH) [1.1.1.22]
ORF02500	4999 & 5000	6-phosphogluconate dehydrogenase, decarboxylating (gnd) [1.1.1.44]
ORF02501	5001 & 5002	WbnE [2.4.1.-]
ORF02502	5003 & 5004	putative glycosyltransferase [2.4.1.-]
ORF02503	5005 & 5006	glycosyl transferase CpsO
ORF02504	5007 & 5008	rhamnosyl transferase Cps6bS
ORF02505	5009 & 5010	O-antigen modification protein
ORF02506	5011 & 5012	rfbX protein
ORF02507	5013 & 5014	dTDP-4-dehydrorhamnose 3,5-epimerase (rfbC) [5.1.3.13]
ORF02508	5015 & 5016	glucose-1-phosphate thymidylyltransferase (rfbA) [2.7.7.24]
ORF02509	5017 & 5018	dTDP-4-dehydrorhamnose reductase (rfbD) [1.1.1.133]
ORF02510	5019 & 5020	dTDP-glucose 4,6-dehydratase (rfbB) [4.2.1.46]
ORF02511	5021 & 5022	regulatory protein GalF (galF)
ORF02512	5023 & 5024	Colanic acid biosynthesis protein wcaM
ORF02513	5025 & 5026	Amylovoran biosynthesis glycosyl transferase amsK [2.-.-.-]
ORF02514	5027 & 5028	Colanic acid biosynthesis protein wcaK [2.-.-.-]
ORF02515	5029 & 5030	Lipopolysaccharide biosynthesis protein wzxC
ORF02516	5031 & 5032	glycosyl transferase (WcaJ) [2.7.-.-]
ORF02517	5033 & 5034	Phosphomannomutase
ORF02518	5035 & 5036	mannose-1-phosphate guanylyltransferase-mannose-6-phosphate isomerase
ORF02519	5037 & 5038	lipopolysaccharide biosynthesis protein, putative
ORF02520	5039 & 5040	GDP-mannose mannosyl hydrolase [3.6.1.-]
ORF02521	5041 & 5042	GDP-fucose synthetase chain A (GER1) [1.1.1.271]
ORF02522	5043 & 5044	GDP-mannose 4,6-dehydratase (gmd) [4.2.1.47]
ORF02523	5045 & 5046	acetyltransferase, CysE-LacA-LpxA-NodL family, putative [2.3.1.-]

ORF02524	5047 & 5048	glycosyl transferase, group 2 family protein, putative
ORF02525	5049 & 5050	Putative colanic acid polymerase
ORF02526	5051 & 5052	possible glycosyl transferase
ORF02527	5053 & 5054	serine acetyltransferase [2.3.1.-]
ORF02528	5055 & 5056	possible glycosyl transferase
ORF02529	5057 & 5058	Tyrosine-protein kinase wzc
ORF02530	5059 & 5060	Low molecular weight protein-tyrosine-phosphatase wzb [3.1.3.48]
ORF02531	5061 & 5062	membrane protein
ORF02532	5063 & 5064	putative transport protein
ORF02533	5065 & 5066	unnamed protein product
ORF02534	5067 & 5068	PHIKZ114
ORF02535	5069 & 5070	Protein asmA precursor
ORF02536	5071 & 5072	deoxycytidine triphosphate deaminase (dcd) [3.5.4.13]
ORF02537	5073 & 5074	uridine kinase (udk) [2.7.1.48]
ORF02538	5075 & 5076	MASE1 domain family
ORF02539	5077 & 5078	Ada regulatory protein, putative [3.2.2.21]
ORF02540	5079 & 5080	hypothetical protein
ORF02541	5081 & 5082	Molecular chaperone
ORF02542	5083 & 5084	conserved hypothetical protein
ORF02543	5085 & 5086	conserved hypothetical protein
ORF02544	5087 & 5088	von Willebrand factor type A domain protein
ORF02545	5089 & 5090	putative membrane protein
ORF02546	5091 & 5092	AcrB-AcrD-AcrF (HAE1)
ORF02547	5093 & 5094	AcrB-AcrD-AcrF family membrane protein
ORF02548	5095 & 5096	MFS superfamily drug efflux pump
ORF02549	5097 & 5098	sensor histidine kinase SrrB, putative [2.7.3.-]
ORF02550	5099 & 5100	Transcriptional regulatory protein baeR (ResD)
ORF02551	5101 & 5102	Domain of unknown function (DUF1508) family
ORF02552	5103 & 5104	conserved hypothetical protein
ORF02553	5105 & 5106	conserved hypothetical protein
ORF02554	5107 & 5108	conserved hypothetical protein
ORF02555	5109 & 5110	conserved hypothetical protein
ORF02556	5111 & 5112	YegQ [3.4.-.-]
ORF02557	5113 & 5114	conserved hypothetical protein TIGR00147
ORF02558	5115 & 5116	Galactitol utilization operon repressor (fragment)
ORF02559	5117 & 5118	hexitol dehydrogenase [1.1.1.251]
ORF02560	5119 & 5120	PTS system, sorbitol-specific IIC component (EIIC-GAT)
ORF02561	5121 & 5122	PTS system, galactitol-specific IIB component (EIIB-Gat) (Galacticol-permease IIB component) (Phosphotransferase enzyme II, B component)(EC 2.7.1.69) [2.7.1.69]
ORF02562	5123 & 5124	PTS system, galactitol-specific IIA component (EIIA-Gat) (Galacticol-permease IIA component) (Phosphotransferase enzyme II, A component)(EC 2.7.1.69) (EIIA-GAT) [2.7.1.69]
ORF02563	5125 & 5126	PUTATIVE TAGATOSE 6-PHOSPHATE KINASE PROTEIN [2.7.1.144]
ORF02564	5127 & 5128	class II aldolase, tagatose bisphosphate family [4.1.2.-]
ORF02565	5129 & 5130	dehydrin [4.1.2.13]
ORF02566	5131 & 5132	nucleoside permease NupG, putative
ORF02567	5133 & 5134	ADP-ribosylglycohydrolase, putative
ORF02568	5135 & 5136	transcriptional regulator, GntR family, putative
ORF02569	5137 & 5138	Ribokinase (EC 2.7.1.15). [2.7.1.15]
ORF02570	5139 & 5140	glycosyl hydrolase, family 25 [3.2.1.17]
ORF02571	5141 & 5142	phosphomethylpyrimidine kinase (thiD) [2.7.4.7]
ORF02572	5143 & 5144	hydroxyethylthiazole kinase (thiM) [2.7.1.50]

ORF02573	5145 & 5146	Uncharacterized BCR, COG1937 family
ORF02574	5147 & 5148	NirC
ORF02575	5149 & 5150	conserved hypothetical protein
ORF02576	5151 & 5152	conserved hypothetical protein
ORF02577	5153 & 5154	Hypothetical outer membrane usher protein yehB precursor
ORF02578	5155 & 5156	Hypothetical fimbrial chaperone yehC precursor
ORF02579	5157 & 5158	Fimbrial protein subfamily
ORF02580	5159 & 5160	Mrp protein (mrp)
ORF02581	5161 & 5162	Methionyl-tRNA synthetase (metG) [6.1.1.10]
ORF02582	5163 & 5164	molybdate metabolism regulator, second fragment 2 (fragment)
ORF02583	5165 & 5166	yehI (fragment)
ORF02584	5167 & 5168	yehI (fragment)
ORF02585	5169 & 5170	conserved hypothetical protein
ORF02586	5171 & 5172	conserved hypothetical protein
ORF02587	5173 & 5174	VWA domain containing CoxE-like protein family
ORF02588	5175 & 5176	yehQ gene product
ORF02589	5177 & 5178	Hypothetical lipoprotein yehR precursor
ORF02590	5179 & 5180	uncharacterized protein conserved in bacteria
ORF02591	5181 & 5182	unnamed protein product
ORF02592	5183 & 5184	putative 2-component sensor protein
ORF02593	5185 & 5186	MerR-like regulator A
ORF02594	5187 & 5188	glycine betaine-l-proline transport system permease protein prow (AE005444)
ORF02595	5189 & 5190	putative membrane protein
ORF02596	5191 & 5192	amino acid ABC transporter, ATP-binding protein (AE005444)
ORF02597	5193 & 5194	ABC transporter, permease protein (AE005444)
ORF02598	5195 & 5196	glycine betaine-L-proline ABC transporter, periplasmic substrate-binding protein, putative
ORF02599	5197 & 5198	yohA (STI) [3.2.1.21]
ORF02600	5199 & 5200	D-lactate dehydrogenase
ORF02601	5201 & 5202	beta-lactamase
ORF02602	5203 & 5204	Protein of unknown function (DUF1282) superfamily
ORF02603	5205 & 5206	DedA family protein
ORF02604	5207 & 5208	yohF [1.-.-.-]
ORF02605	5209 & 5210	Putative channel-filament proteins
ORF02606	5211 & 5212	Dihydrouridine synthase (Dus) superfamily
ORF02607	5213 & 5214	LrgA family subfamily, putative
ORF02608	5215 & 5216	membrane protein, putative
ORF02609	5217 & 5218	cytidine deaminase (cdd) [3.5.4.5]
ORF02610	5219 & 5220	SanA protein
ORF02611	5221 & 5222	conserved hypothetical protein
ORF02612	5223 & 5224	glutamate synthase, small subunit (NADPH)
ORF02613	5225 & 5226	dihydroorotase dehydrogenase (pyrD)
ORF02614	5227 & 5228	conserved hypothetical protein
ORF02615	5229 & 5230	ribose ABC transporter, permease protein (membrane)
ORF02616	5231 & 5232	Galactoside transport ATP-binding protein mglA (atp_bind)
ORF02617	5233 & 5234	D-galactose-binding periplasmic protein precursor (GBP) (D-galactose-D-glucose binding protein) (GGBP)
ORF02618	5235 & 5236	Mgl repressor and galactose ultrainduction factor
ORF02619	5237 & 5238	unnamed protein product
ORF02620	5239 & 5240	conserved hypothetical protein
ORF02621	5241 & 5242	GTP cyclohydrolase I (folE) [3.5.4.16]
ORF02622	5243 & 5244	carboxylesterase [3.1.1.-]

ORF02623	5245 & 5246	Colicin I receptor precursor
ORF02624	5247 & 5248	lysine-specific permease
ORF02625	5249 & 5250	transcriptional regulator, LysR family
ORF02626	5251 & 5252	membrane protein, putative
ORF02627	5253 & 5254	Endonuclease IV (Endodeoxyribonuclease IV) [3.1.21.2]
ORF02628	5255 & 5256	yeil
ORF02629	5257 & 5258	inosine-uridine preferring nucleoside hydrolase (AL355920)
ORF02630	5259 & 5260	Regulatory protein nsr
ORF02631	5261 & 5262	nucleoside transporter
ORF02632	5263 & 5264	uncharacterized enzyme involved in pigment biosynthesis
ORF02633	5265 & 5266	yeil
ORF02634	5267 & 5268	PTS system, fructose-specific IIBC component [2.7.1.69]
ORF02635	5269 & 5270	1-phosphofructokinase (Fructose 1-phosphate kinase) (fruK) [2.7.1.56]
ORF02636	5271 & 5272	PTS system, fructose-specific IIA-FPr component (EIIA-Fru) (Fructose-permease IIA-FPr component) (Phosphotransferase enzyme II, A-FPrcomponent) (Phosphotransferase FPr protein) (Pseudo-HPr)(EIII-Fru) (Fructose PTS diphosphoryl transfer protein) (EIII-FRU) [2.7.1.69]
ORF02637	5273 & 5274	conserved hypothetical protein
ORF02638	5275 & 5276	Sugar efflux transporter B (orf104)
ORF02639	5277 & 5278	translation elongation factor EF-P (EF-P)
ORF02640	5279 & 5280	D-MANNONATE OXIDOREDUCTASE
ORF02641	5281 & 5282	CobW-P47K family protein domain protein
ORF02642	5283 & 5284	PAP2 superfamily domain protein
ORF02643	5285 & 5286	Lipoprotein spr precursor (spr)
ORF02644	5287 & 5288	Rtn protein
ORF02645	5289 & 5290	ABC transporter substrate-binding protein
ORF02646	5291 & 5292	peptide ABC transporter, permease protein
ORF02647	5293 & 5294	ABC transporter, permease protein
ORF02648	5295 & 5296	ABC transporter, nucleotide binding-ATPase protein [peptide]
ORF02649	5297 & 5298	unnamed protein product
ORF02650	5299 & 5300	bicyclomycin resistance protein
ORF02651	5301 & 5302	ribosomal small subunit pseudouridine synthase A
ORF02652	5303 & 5304	yejH
ORF02653	5305 & 5306	50S ribosomal protein L25
ORF02654	5307 & 5308	nucleoid-associated protein
ORF02655	5309 & 5310	hypothetical protein
ORF02656	5311 & 5312	Protein of unknown function (DUF1414) superfamily
ORF02657	5313 & 5314	Predicted hydrolase of alkaline phosphatase superfamily
ORF02658	5315 & 5316	yejO
ORF02659	5317 & 5318	Nitrate-nitrite response regulator protein narP
ORF02660	5319 & 5320	Cytochrome c-type biogenesis protein ccmH precursor (nrfF)
ORF02661	5321 & 5322	Thiol:disulfide interchange protein dsbE (Cytochrome c biogenesisprotein ccmG) (dsbE)
ORF02662	5323 & 5324	cytochrome c-type biogenesis protein CcmF (ccmF)
ORF02663	5325 & 5326	Cytochrome c-type biogenesis protein ccmE
ORF02664	5327 & 5328	Heme exporter protein D (Cytochrome c-type biogenesis protein ccmD)-related protein
ORF02665	5329 & 5330	heme exporter protein C
ORF02666	5331 & 5332	heme exporter protein CcmB (ccmB)
ORF02667	5333 & 5334	heme exporter protein CcmA (ccmA)
ORF02668	5335 & 5336	Cytochrome c-type protein napC
ORF02669	5337 & 5338	periplasmic nitrate reductase, diheme cytochrome c subunit (napB)

ORF02670	5339 & 5340	Ferredoxin-type protein napH (napH)
ORF02671	5341 & 5342	Ferredoxin-type protein napG (napG)
ORF02672	5343 & 5344	periplasmic nitrate reductase, large subunit (napA) [1.7.99.4]
ORF02673	5345 & 5346	NapD protein (napD)
ORF02674	5347 & 5348	ferredoxin-type protein NapF (napF)
ORF02675	5349 & 5350	Ecotin
ORF02676	5351 & 5352	malate:quinone-oxidoreductase (mqo) [1.1.99.16]
ORF02677	5353 & 5354	hypothetical protein
ORF02678	5355 & 5356	MdlB protein
ORF02679	5357 & 5358	Alkylated DNA repair protein alkB (alkB)
ORF02680	5359 & 5360	O6-methylguanine-DNA methyltransferase; transcription activator-repressor [2.1.1.63]
ORF02681	5361 & 5362	thiamine biosynthesis lipoprotein ApbE, putative
ORF02682	5363 & 5364	Outer membrane protein C precursor (Porin ompC) (Outer membraneprotein 1B) (Ibc)
ORF02683	5365 & 5366	YojQ [2.7.3.-]
ORF02684	5367 & 5368	positive response regulator for colanic capsule biosynthesis
ORF02685	5369 & 5370	Sensor protein rcsC
ORF02686	5371 & 5372	Sensor protein atoS
ORF02687	5373 & 5374	Acetoacetate metabolism Regulatory protein atoC (atoC)
ORF02688	5375 & 5376	Acetate CoA-transferase alpha subunit [2.8.3.8]
ORF02689	5377 & 5378	Acetate CoA-transferase beta subunit (atoA) [2.8.3.8]
ORF02690	5379 & 5380	membrane protein, putative
ORF02691	5381 & 5382	Acetyl-CoA acetyltransferase (atoB) [2.3.1.9]
ORF02692	5383 & 5384	conserved hypothetical protein
ORF02693	5385 & 5386	conserved hypothetical protein
ORF02694	5387 & 5388	Alpha-2-macroglobulin family N-terminal region family
ORF02695	5389 & 5390	Protein of unknown function (DUF1175) superfamily
ORF02696	5391 & 5392	conserved hypothetical protein
ORF02697	5393 & 5394	DNA gyrase, A subunit (gyrA) [5.99.1.3]
ORF02698	5395 & 5396	ubiquinone biosynthesis O-methyltransferase (ubiG) [2.1.1.-]
ORF02699	5397 & 5398	similar to [SwissProt Accession Number P45508]
ORF02700	5399 & 5400	ribonucleoside diphosphate reductase 1, alpha subunit, B1 (nrdA) [1.17.4.1]
ORF02701	5401 & 5402	ribonucleoside diphosphage reductase 1, beta subunit, B2
ORF02702	5403 & 5404	adrenodoxin family ferredoxin
ORF02703	5405 & 5406	Protein inaA
ORF02704	5407 & 5408	glycerophosphodiester phosphodiesterase, periplasmic
ORF02705	5409 & 5410	glycerol-3-phosphate transporter (glpT)
ORF02706	5411 & 5412	glpD2, putative [1.1.99.5]
ORF02707	5413 & 5414	Anaerobic glycerol-3-phosphate dehydrogenase subunit B
ORF02708	5415 & 5416	Anaerobic glycerol-3-phosphate dehydrogenase subunit C [1.1.99.5]
ORF02709	5417 & 5418	conserved hypothetical protein
ORF02710	5419 & 5420	transposase
ORF02711	5421 & 5422	transposase
ORF02712	5423 & 5424	similar to [SwissProt Accession Number P23522]
ORF02713	5425 & 5426	major facilitator family transporter
ORF02714	5427 & 5428	Mandelate racemase - muconate lactonizing enzyme, C-terminal domain protein
ORF02715	5429 & 5430	transcriptional regulator, IclR family, putative
ORF02716	5431 & 5432	CinA-like protein
ORF02717	5433 & 5434	YfaZ precursor superfamily
ORF02718	5435 & 5436	hydrolase, NUDIX family, putative
ORF02719	5437 & 5438	protein induced by aluminum

ORF02720	5439 & 5440	lipopolysaccharide biosynthesis protein
ORF02721	5441 & 5442	Glycosyl transferase arnC (Ara4N transferase) (Polymixinresistance protein pmrF) [2.-.-.-]
ORF02722	5443 & 5444	Formyl transferase, C-terminal domain protein
ORF02723	5445 & 5446	PbgP4 protein
ORF02724	5447 & 5448	melittin resistance protein PqaB
ORF02725	5449 & 5450	sucrose-6 phosphate hydrolase
ORF02726	5451 & 5452	conserved hypothetical protein
ORF02727	5453 & 5454	Polymyxin B resistance protein pmrD
ORF02728	5455 & 5456	O-succinylbenzoate-CoA ligase (menE) [6.2.1.26]
ORF02729	5457 & 5458	o-succinylbenzoic acid (OSB) synthetase (menC) [4.2.1.-]
ORF02730	5459 & 5460	naphthoate synthase (menB) [4.1.3.36]
ORF02731	5461 & 5462	hydrolase, alpha-beta hydrolase fold family, putative
ORF02732	5463 & 5464	2-succinyl-6-hydroxy-2,4-cyclohexadiene-1-carboxylic acid synthase-2-oxoglutarate decarboxylase (menD) [4.1.1.71]
ORF02733	5465 & 5466	Menaquinone-specific isochorismate synthase
ORF02734	5467 & 5468	ElaB protein
ORF02735	5469 & 5470	elaA protein VC2565 (putative)
ORF02736	5471 & 5472	metallo-beta-lactamase superfamily protein [3.1.26.11]
ORF02737	5473 & 5474	von Willebrand factor type A domain protein
ORF02738	5475 & 5476	putative aminopeptidase
ORF02739	5477 & 5478	conserved hypothetical protein
ORF02740	5479 & 5480	NADH dehydrogenase I chain N (NUO14) [1.6.99.5]
ORF02741	5481 & 5482	NADH dehydrogenase I chain M (NUO13) [1.6.99.5]
ORF02742	5483 & 5484	NADH dehydrogenase I chain L ECs3162 (NUO12) [1.6.99.5]
ORF02743	5485 & 5486	NADH dehydrogenase I chain L ECs3162 (NUO12) [1.6.99.5]
ORF02744	5487 & 5488	NADH dehydrogenase I, K subunit (NUO11) [1.6.5.3]
ORF02745	5489 & 5490	NADH-quinone oxidoreductase chain J (NADH dehydrogenaseI, chain J) (NDH-1, chain J) (NUO10) [1.6.99.5]
ORF02746	5491 & 5492	NADH DEHYDROGENASE I CHAIN I (EC 1.6.5.3) (NADH-UBIQUINONE OXIDOREDUCTASE CHAIN 9) (NUO9) [1.6.5.3]
ORF02747	5493 & 5494	NADH dehydrogenase I chain H (NUO8) [1.6.99.5]
ORF02748	5495 & 5496	NADH DEHYDROGENASE I CHAIN G (EC 1.6.5.3) (NADH-UBIQUINONE OXIDOREDUCTASE CHAIN 7) (NUO7) (FRAGMENT) [1.6.5.3]
ORF02749	5497 & 5498	NADH-quinone oxidoreductase, F subunit (nuoF)
ORF02750	5499 & 5500	NADH-quinone oxidoreductase chain E (NADH dehydrogenaseI, chain E) (NDH-1, chain E) (NUO5) [1.6.99.5]
ORF02751	5501 & 5502	NADH dehydrogenase I chain C-D (NUO4) [1.6.99.5]
ORF02752	5503 & 5504	NADH-quinone oxidoreductase chain B (NADH dehydrogenaseI, chain B) (NDH-1, chain B) (NUO2) (NUO2) [1.6.99.5]
ORF02753	5505 & 5506	NADH-quinone oxidoreductase chain A (NADH dehydrogenaseI, chain A) (NDH-1, chain A) (NUO1) [1.6.99.5]
ORF02754	5507 & 5508	LysR family NADH dehydrogenase transcriptional regulator (RssB)
ORF02755	5509 & 5510	hypothetical protein
ORF02756	5511 & 5512	aminotransferase, classes I and II (ASPAT) [2.6.1.-]
ORF02757	5513 & 5514	b2291
ORF02758	5515 & 5516	unnamed protein product
ORF02759	5517 & 5518	hydrolase, haloacid dehalogenase-like family [3.1.3.-]
ORF02760	5519 & 5520	Protein yfbU
ORF02761	5521 & 5522	Hypothetical UPF0208 protein yfbV
ORF02762	5523 & 5524	acetate kinase (ackA) [2.7.2.1]
ORF02763	5525 & 5526	Phosphate acetyltransferase

ORF02764	5527 & 5528	predicted membrane protein
ORF02765	5529 & 5530	IPP isomerase type 1 family protein, putative [3.6.-.-]
ORF02766	5531 & 5532	phosphoesterase, putative subfamily
ORF02767	5533 & 5534	Glutathione S-transferase, N-terminal domain protein
ORF02768	5535 & 5536	glutathione S-transferase, putative
ORF02769	5537 & 5538	dihydroneopterin aldolase (folB) [4.1.2.25]
ORF02770	5539 & 5540	conserved hypothetical protein TIGR01777
ORF02771	5541 & 5542	conserved hypothetical protein subfamily
ORF02772	5543 & 5544	ATP-binding component of histidine transport ECs3190
ORF02773	5545 & 5546	histidine transport system membrane protein M (membrane)
ORF02774	5547 & 5548	amino acid ABC transporter, permease protein
ORF02775	5549 & 5550	Histidine-binding periplasmic protein precursor (HBP)
ORF02776	5551 & 5552	Lysine-arginine-ornithine-binding periplasmic protein precursor (LAO-binding protein)
ORF02777	5553 & 5554	3-octaprenyl-4-hydroxybenzoate carboxy-lyase (Polyprenylp-hydroxybenzoate decarboxylase) [4.1.1.-]
ORF02778	5555 & 5556	amidophosphoribosyltransferase (purF) [2.4.2.14]
ORF02779	5557 & 5558	CvpA family protein (cvpA)
ORF02780	5559 & 5560	DedD protein
ORF02781	5561 & 5562	FolC bifunctional protein [6.3.2.17]
ORF02782	5563 & 5564	acetyl-CoA carboxylase, carboxyl transferase, beta subunit (accD) [6.4.1.2]
ORF02783	5565 & 5566	DedA protein
ORF02784	5567 & 5568	tRNA pseudouridine synthase A (truA) [4.2.1.70]
ORF02785	5569 & 5570	USG-1 protein [1.2.1.-]
ORF02786	5571 & 5572	Erythronate-4-phosphate dehydrogenase [1.1.1.-]
ORF02787	5573 & 5574	hypothetical protein
ORF02788	5575 & 5576	Int
ORF02789	5577 & 5578	Regulatory protein cox
ORF02790	5579 & 5580	hypothetical protein
ORF02791	5581 & 5582	unknown protein encoded by prophage CP-933T
ORF02792	5583 & 5584	unknown protein encoded by prophage CP-933T
ORF02793	5585 & 5586	unknown protein encoded by prophage CP-933T
ORF02794	5587 & 5588	hypothetical protein
ORF02795	5589 & 5590	conserved hypothetical protein
ORF02796	5591 & 5592	unknown protein encoded by prophage CP-933T
ORF02797	5593 & 5594	unknown protein encoded by prophage CP-933T -related protein
ORF02798	5595 & 5596	conserved hypothetical protein
ORF02799	5597 & 5598	Fels-2 prophage protein
ORF02800	5599 & 5600	gpH
ORF02801	5601 & 5602	gpU (gpG)
ORF02802	5603 & 5604	gpU prime (gpG)
ORF02803	5605 & 5606	DNA-invertase (pin)
ORF02804	5607 & 5608	Fels-2 prophage protein (gpU)
ORF02805	5609 & 5610	phage tail tape meausure protein, TP901 family, putative
ORF02806	5611 & 5612	probable phage tail protein -related protein
ORF02807	5613 & 5614	probable tail protein (gpE)
ORF02808	5615 & 5616	phage major tail tube protein
ORF02809	5617 & 5618	Phage tail sheath protein
ORF02810	5619 & 5620	hypothetical protein
ORF02811	5621 & 5622	bacteriophage late gene control protein D
ORF02812	5623 & 5624	hypothetical protein
ORF02813	5625 & 5626	Phage transcriptional activator, Ogr-Delta

ORF02814	5627 & 5628	conserved hypothetical protein
ORF02815	5629 & 5630	hypothetical protein
ORF02816	5631 & 5632	hypothetical protein
ORF02817	5633 & 5634	DIV protein (FRAGMENT)
ORF02818	5635 & 5636	Hypothetical UPF0226 protein yfcJ
ORF02819	5637 & 5638	3-oxoacyl-[acyl-carrier-protein] synthase I (Beta-ketoacyl-ACP synthase I) (KAS I) [2.3.1.41]
ORF02820	5639 & 5640	Glycine-D-amino acid oxidases (deaminating)
ORF02821	5641 & 5642	conserved hypothetical protein
ORF02822	5643 & 5644	similar to [SwissProt Accession Number P44255]
ORF02823	5645 & 5646	predicted permease (ORF9)
ORF02824	5647 & 5648	Penicillin-insensitive murein endopeptidase precursor [3.4.99.-]
ORF02825	5649 & 5650	chorismate synthase (aroC) [4.2.3.5]
ORF02826	5651 & 5652	Predicted rRNA or tRNA methylase [2.1.1.72]
ORF02827	5653 & 5654	Smr domain protein
ORF02828	5655 & 5656	conserved hypothetical protein
ORF02829	5657 & 5658	minor fimbrial subunit StfG
ORF02830	5659 & 5660	minor fimbrial subunit StfF
ORF02831	5661 & 5662	fimbrial subunit
ORF02832	5663 & 5664	periplasmic fimbrial chaperone StfD
ORF02833	5665 & 5666	outer membrane usher protein StfC
ORF02834	5667 & 5668	major fimbrial subunit StfA
ORF02835	5669 & 5670	hypothetical protein
ORF02836	5671 & 5672	phosphohistidine phosphatase SixA (sixA) [3.1.3.-]
ORF02837	5673 & 5674	fatty oxidation complex, alpha subunit FadJ (fadJ) [4.2.1.17 1.1.1.35 5.1.2.3]
ORF02838	5675 & 5676	acetyl-CoA C-acyltransferase FadI (fadI) [2.3.1.16]
ORF02839	5677 & 5678	conserved hypothetical protein superfamily
ORF02840	5679 & 5680	Long-chain fatty acid transport protein precursor (Outer membrane fadLprotein) (Outer membrane flp protein)
ORF02841	5681 & 5682	VACJ LIPOPROTEIN PRECURSOR. (vacJ)
ORF02842	5683 & 5684	probable transport yfdC
ORF02843	5685 & 5686	putative prophage integrase
ORF02844	5687 & 5688	hypothetical protein
ORF02845	5689 & 5690	endo-alpha-sialidase [3.2.1.129]
ORF02846	5691 & 5692	hypothetical protein
ORF02847	5693 & 5694	endo-alpha-sialidase [3.2.1.129]
ORF02848	5695 & 5696	Antirepressor protein ant
ORF02849	5697 & 5698	unnamed protein product; pot. mnt-gene product (aa 1-83)
ORF02850	5699 & 5700	DNA transfer protein
ORF02851	5701 & 5702	hypothetical protein
ORF02852	5703 & 5704	DNA transfer protein
ORF02853	5705 & 5706	DNA transfer protein gp7
ORF02854	5707 & 5708	head assembly protein
ORF02855	5709 & 5710	DNA stabilization protein
ORF02856	5711 & 5712	DNA stabilization protein
ORF02857	5713 & 5714	gene 7 protein
ORF02858	5715 & 5716	hypothetical protein
ORF02859	5717 & 5718	coat protein, putative
ORF02860	5719 & 5720	P23, putative
ORF02861	5721 & 5722	portal protein
ORF02862	5723 & 5724	phage terminase, large subunit, PBSX family
ORF02863	5725 & 5726	conserved hypothetical protein

ORF02864	5727 & 5728	gene 67 protein
ORF02865	5729 & 5730	alternate start at bp 59; ORF
ORF02866	5731 & 5732	Bacteriophage lysis protein
ORF02867	5733 & 5734	lysozyme [3.2.1.17]
ORF02868	5735 & 5736	phage holin, lambda family
ORF02869	5737 & 5738	gene 59 protein
ORF02870	5739 & 5740	Phage NinH protein superfamily
ORF02871	5741 & 5742	holiday-junction resolvase [3.1.22.-]
ORF02872	5743 & 5744	Gp66
ORF02873	5745 & 5746	DNA-binding protein Roi (Ant1)
ORF02874	5747 & 5748	NinF protein superfamily
ORF02875	5749 & 5750	NinX
ORF02876	5751 & 5752	Protein ninE-related protein
ORF02877	5753 & 5754	Protein ninB
ORF02878	5755 & 5756	DnaB analogue [3.6.1.-]
ORF02879	5757 & 5758	Gp54
ORF02880	5759 & 5760	Regulatory protein CII (cII)
ORF02881	5761 & 5762	hypothetical protein
ORF02882	5763 & 5764	gene 33 protein
ORF02883	5765 & 5766	gene 33 protein
ORF02884	5767 & 5768	Kil protein-related protein
ORF02885	5769 & 5770	Gp42.1
ORF02886	5771 & 5772	Gp40
ORF02887	5773 & 5774	gene 25 protein
ORF02888	5775 & 5776	hypothetical protein
ORF02889	5777 & 5778	Gp37
ORF02890	5779 & 5780	Protein of unknown function (DUF551) family
ORF02891	5781 & 5782	conserved hypothetical protein
ORF02892	5783 & 5784	gene 18 protein-related protein
ORF02893	5785 & 5786	D-serine deaminase transcriptional activator (dsdC)
ORF02894	5787 & 5788	DsdX permease
ORF02895	5789 & 5790	D-serine ammonia-lyase (dsdA) [4.3.1.18]
ORF02896	5791 & 5792	Multidrug resistance protein Y
ORF02897	5793 & 5794	Multidrug resistance protein K
ORF02898	5795 & 5796	conserved hypothetical protein
ORF02899	5797 & 5798	Positive transcription regulator evgA
ORF02900	5799 & 5800	Sensor protein evgS precursor [2.7.3.-]
ORF02901	5801 & 5802	CAIB-BAIF family protein
ORF02902	5803 & 5804	similar to [SwissProt Accession Number P45869]
ORF02903	5805 & 5806	oxcA [4.1.1.8]
ORF02904	5807 & 5808	CAIB-BAIF family protein [2.8.3.16]
ORF02905	5809 & 5810	YfdX protein precursor
ORF02906	5811 & 5812	conserved hypothetical protein
ORF02907	5813 & 5814	DDG protein
ORF02908	5815 & 5816	transaminase [similarity] (ASPAT) [2.6.1.-]
ORF02909	5817 & 5818	Histidine kinase family
ORF02910	5819 & 5820	Autolysin response regulator
ORF02911	5821 & 5822	transcription regulator VC1825
ORF02912	5823 & 5824	Phosphoenolpyruvate-protein phosphotransferase ptsA(Phosphotransferase system, enzyme I) (Enzyme I-Ani) [2.7.3.9]
ORF02913	5825 & 5826	frv operon protein
ORF02914	5827 & 5828	proline dipeptidase [3.4.-.-]

ORF02915	5829 & 5830	PTS system, fructose specific IIABC components , putative [2.7.1.69]
ORF02916	5831 & 5832	PTS system, fructose-like-2 IIB component 1 (phosphotransferase
ORF02917	5833 & 5834	glucokinase (glk) [2.7.1.2]
ORF02918	5835 & 5836	Putative ion-transport protein yfeO
ORF02919	5837 & 5838	conserved hypothetical protein
ORF02920	5839 & 5840	transport protein, NRAMP family
ORF02921	5841 & 5842	Nucleoside permease nupC
ORF02922	5843 & 5844	Nucleoside permease nupC
ORF02923	5845 & 5846	similar to [SwissProt Accession Number P23842] start codon is not identified yet
ORF02924	5847 & 5848	similar to [SwissProt Accession Number P27239] start codon is not identified yet
ORF02925	5849 & 5850	similar to [SwissProt Accession Number P27239] start codon is not identified yet
ORF02926	5851 & 5852	glutamyl-tRNA synthetase (gltX) [6.1.1.17]
ORF02927	5853 & 5854	transcriptional regulator, LysR family, putative
ORF02928	5855 & 5856	conserved hypothetical protein
ORF02929	5857 & 5858	nucleoside permease NupG
ORF02930	5859 & 5860	xanthosine phosphorylase (xapA) [2.4.2.1]
ORF02931	5861 & 5862	hypothetical protein
ORF02932	5863 & 5864	Protein of unknown function (DUF1384) superfamily
ORF02933	5865 & 5866	OsmT protein
ORF02934	5867 & 5868	similar to [SwissProt Accession Number P39836] start codon is not identified yet
ORF02935	5869 & 5870	conserved hypothetical protein
ORF02936	5871 & 5872	DNA ligase, NAD-dependent (ligA) [6.5.1.2]
ORF02937	5873 & 5874	cell division protein ZipA (zipA)
ORF02938	5875 & 5876	CysZ protein
ORF02939	5877 & 5878	cysteine synthase A (cysK) [2.5.1.47]
ORF02940	5879 & 5880	Phosphocarrier protein HPr (Histidine-containing protein) (ptsH) [2.7.1.69]
ORF02941	5881 & 5882	phosphoenolpyruvate-protein phosphotransferase (ptsI) [2.7.3.9]
ORF02942	5883 & 5884	phosphotransferase system enzyme II , glucose-specific, factor III (crr) [2.7.1.69]
ORF02943	5885 & 5886	pyridoxal kinase [2.7.1.35]
ORF02944	5887 & 5888	conserved hypothetical protein
ORF02945	5889 & 5890	cysteine synthase B (cysM) [2.5.1.47]
ORF02946	5891 & 5892	Sulfate-thiosulfate import ATP-binding protein cysA(Sulfate-transporting ATPase) (atp_bind) [3.6.3.25]
ORF02947	5893 & 5894	sulfate ABC transporter, permease protein CysW (cysW)
ORF02948	5895 & 5896	sulfate ABC transporter, permease protein CysT (cysT)
ORF02949	5897 & 5898	thiosulfate binding protein
ORF02950	5899 & 5900	3-oxoacyl-(acyl-carrier-protein) reductase
ORF02951	5901 & 5902	glucokinase regulator-related protein
ORF02952	5903 & 5904	PTS system, sucrose-specific IIBC component (EIIBC-Scr) (Sucrose-permease IIBC component) (Phosphotransferase enzyme II, BC component)(EC 2.7.1.69) (EII-Scr) [2.7.1.69]
ORF02953	5905 & 5906	tyrA protein VC2145
ORF02954	5907 & 5908	Protein of unknown function (DUF1131) superfamily
ORF02955	5909 & 5910	conserved hypothetical protein
ORF02956	5911 & 5912	acetyltransferase, GNAT family family
ORF02957	5913 & 5914	N-acetylmuramoyl-l-alanine amidase I [3.5.1.28]
ORF02958	5915 & 5916	coproporphyrinogen III oxidase, aerobic (hemF) [1.3.3.3]
ORF02959	5917 & 5918	Ethanolamine operon Regulatory protein
ORF02960	5919 & 5920	Ethanolamine utilization protein eutK precursor
ORF02961	5921 & 5922	Ethanolamine utilization protein eutL (eutL)
ORF02962	5923 & 5924	ethanolamine ammonia-lyase, light subunit, putative [4.3.1.7]
ORF02963	5925 & 5926	ethanolamine ammonia-lyase, large subunit (eutB) [4.3.1.7]

ORF02964	5927 & 5928	Ethanolamine utilization protein eutA
ORF02965	5929 & 5930	Ethanolamine utilization protein eutH
ORF02966	5931 & 5932	Ethanolamine utilization protein eutG
ORF02967	5933 & 5934	Ethanolamine utilization protein eutJ (EutJ)
ORF02968	5935 & 5936	aldehyde-alcohol dehydrogenase (EutE)
ORF02969	5937 & 5938	carbon dioxide concentrating mechanism protein CcmL, putative
ORF02970	5939 & 5940	detox protein (EutM)
ORF02971	5941 & 5942	phosphate acetyltransferase (pta) [2.3.1.8]
ORF02972	5943 & 5944	Ethanolamine utilization cobalamin adenosyltransferase [2.5.1.17]
ORF02973	5945 & 5946	Ethanolamine utilization protein eutQ
ORF02974	5947 & 5948	Ethanolamine utilization protein eutP
ORF02975	5949 & 5950	ethanolamine utilization protein eutS
ORF02976	5951 & 5952	NADP-dependent malic enzyme (NADP-ME) [1.1.1.40]
ORF02977	5953 & 5954	transaldolase (tal) [2.2.1.2]
ORF02978	5955 & 5956	transketolase (tkt) [2.2.1.1]
ORF02979	5957 & 5958	Protein of unknown function (DUF1176) superfamily
ORF02980	5959 & 5960	conserved hypothetical protein
ORF02981	5961 & 5962	conserved hypothetical protein TIGR00052
ORF02982	5963 & 5964	similar to [SwissProt Accession Number P37127] start codon is not identified yet (GltD) [1.4.1.13]
ORF02983	5965 & 5966	Nitrate-nitrite sensor protein narQ
ORF02984	5967 & 5968	1037 amino acids, 113 kDa protein
ORF02985	5969 & 5970	Protein yffB [1.-.-.-]
ORF02986	5971 & 5972	succinyl-diaminopimelate desuccinylase (dapE) [3.5.1.18]
ORF02987	5973 & 5974	conserved hypothetical protein
ORF02988	5975 & 5976	3.1.-.- [3.1.-.-]
ORF02989	5977 & 5978	similar to [SwissProt Accession Number P44140]
ORF02990	5979 & 5980	metallopeptidase, zinc binding [3.4.-.-]
ORF02991	5981 & 5982	phosphoribosylaminoimidazole-succinocarboxamide synthase (purC) [6.3.2.6]
ORF02992	5983 & 5984	Lipoprotein-34 precursor
ORF02993	5985 & 5986	dihydrodipicolinate synthase (dapA) [4.2.1.52]
ORF02994	5987 & 5988	transcriptional regulation of gcv operon
ORF02995	5989 & 5990	bcp [1.11.1.-]
ORF02996	5991 & 5992	predicted permease
ORF02997	5993 & 5994	Peptidase family M48 family [3.4.-.-]
ORF02998	5995 & 5996	arsenate reductase (arsC) [1.20.4.1]
ORF02999	5997 & 5998	ATPase involved in DNA replication initiation
ORF03000	5999 & 6000	Uracil permease
ORF03001	6001 & 6002	uracil phosphoribosyltransferase (upp) [2.4.2.9]
ORF03002	6003 & 6004	phosphoribosylformylglycinamidine cyclo-ligase (purM) [6.3.3.1]
ORF03003	6005 & 6006	phosphoribosylglycinamide formyltransferase (purN) [2.1.2.2]
ORF03004	6007 & 6008	polyphosphate kinase (ppk) [2.7.4.1]
ORF03005	6009 & 6010	exopolyphosphatase [3.6.1.11]
ORF03006	6011 & 6012	MASE1 domain family
ORF03007	6013 & 6014	conserved hypothetical protein
ORF03008	6015 & 6016	hypothetical protein
ORF03009	6017 & 6018	putative outer membrane lipoprotein
ORF03010	6019 & 6020	probable membrane protein Z3770
ORF03011	6021 & 6022	putative Rz-like protein
ORF03012	6023 & 6024	endolysin
ORF03013	6025 & 6026	holin
ORF03014	6027 & 6028	endo-alpha-sialidase

ORF03015	6029 & 6030	hypothetical protein
ORF03016	6031 & 6032	endo-alpha-sialidase [3.2.1.129]
ORF03017	6033 & 6034	hypothetical protein
ORF03018	6035 & 6036	Gp27
ORF03019	6037 & 6038	hypothetical protein
ORF03020	6039 & 6040	hypothetical protein
ORF03021	6041 & 6042	hypothetical protein
ORF03022	6043 & 6044	conserved hypothetical protein
ORF03023	6045 & 6046	conserved hypothetical protein
ORF03024	6047 & 6048	hypothetical protein
ORF03025	6049 & 6050	Bbp13
ORF03026	6051 & 6052	gp11
ORF03027	6053 & 6054	Bbp20
ORF03028	6055 & 6056	conserved hypothetical protein
ORF03029	6057 & 6058	Bbp16
ORF03030	6059 & 6060	gp08
ORF03031	6061 & 6062	Bbp18
ORF03032	6063 & 6064	hypothetical protein
ORF03033	6065 & 6066	Bbp19
ORF03034	6067 & 6068	Bbp21
ORF03035	6069 & 6070	conserved hypothetical protein
ORF03036	6071 & 6072	hypothetical protein
ORF03037	6073 & 6074	hypothetical protein
ORF03038	6075 & 6076	terminase large subunit
ORF03039	6077 & 6078	conserved hypothetical protein
ORF03040	6079 & 6080	putative repressor
ORF03041	6081 & 6082	conserved hypothetical protein
ORF03042	6083 & 6084	conserved hypothetical protein
ORF03043	6085 & 6086	exonuclease VIII RecE [3.1.11.-]
ORF03044	6087 & 6088	enterohemolysin 1
ORF03045	6089 & 6090	Prophage CP4-57 regulatory protein (AlpA) family
ORF03046	6091 & 6092	conserved hypothetical protein
ORF03047	6093 & 6094	adenine methylase
ORF03048	6095 & 6096	adenine methylase
ORF03049	6097 & 6098	integrase
ORF03050	6099 & 6100	GMP synthase [glutamine-hydrolyzing] (Glutamineamidotransferase) (GMP synthetase) (glutamine-hydro) [6.3.5.2]
ORF03051	6101 & 6102	inosine-5'-monophosphate dehydrogenase (guaB) [1.1.1.205]
ORF03052	6103 & 6104	exodeoxyribonuclease VII, large subunit (xseA) [3.1.11.6]
ORF03053	6105 & 6106	Aec4 precursor
ORF03054	6107 & 6108	SinI homolog
ORF03055	6109 & 6110	Aec1 precursor
ORF03056	6111 & 6112	Protein of unknown function (DUF1407) superfamily
ORF03057	6113 & 6114	predicted GTP-binding protein
ORF03058	6115 & 6116	PQQ enzyme repeat domain protein [2.7.1.-]
ORF03059	6117 & 6118	unnamed protein product
ORF03060	6119 & 6120	histidyl-tRNA synthetase (hisS) [6.1.1.21]
ORF03061	6121 & 6122	4-hydroxy-3-methylbut-2-en-1-yl diphosphate synthase (ispG) [1.17.4.3]
ORF03062	6123 & 6124	similar to [SwissProt Accession Number P27434]
ORF03063	6125 & 6126	radical SAM enzyme, Cfr family
ORF03064	6127 & 6128	Nucleoside diphosphate kinase (ndk) [2.7.4.6]
ORF03065	6129 & 6130	penicillin-binding protein 1C (pbpC)

ORF03066	6131 & 6132	Hypothetical lipoprotein yfhM precursor
ORF03067	6133 & 6134	3-mercaptopyruvate sulfurtransferase (AF109156) [2.8.1.1]
ORF03068	6135 & 6136	enhanced serine sensitivity
ORF03069	6137 & 6138	Cytosol aminopeptidase family, catalytic domain family
ORF03070	6139 & 6140	Protein of unknown function (DUF528) superfamily
ORF03071	6141 & 6142	ferredoxin, 2Fe-2S type, ISC system (fdx)
ORF03072	6143 & 6144	Fe-S protein assembly chaperone HscA (hscA)
ORF03073	6145 & 6146	Fe-S protein assembly co-chaperone HscB (hscB)
ORF03074	6147 & 6148	iron-sulfur cluster assembly protein IscA (iscA)
ORF03075	6149 & 6150	FeS cluster assembly scaffold IscU (iscU)
ORF03076	6151 & 6152	cysteine desulfurase IscS (iscS) [4.4.1.-]
ORF03077	6153 & 6154	iron-sulfur cluster assembly transcription factor IscR (iscR)
ORF03078	6155 & 6156	RNA methyltransferase, TrmH family, group 1
ORF03079	6157 & 6158	Inositol-1-monophosphatase (IMPase) (Inositol-1-phosphatase) (I-1-Pase) (I-1-Pase) [3.1.3.25]
ORF03080	6159 & 6160	conserved hypothetical protein
ORF03081	6161 & 6162	MFS (major facilitator superfamily) transporter
ORF03082	6163 & 6164	csiE
ORF03083	6165 & 6166	DoxX subfamily, putative
ORF03084	6167 & 6168	Aldose 1-epimerase superfamily
ORF03085	6169 & 6170	oxidoreductase, zinc-binding dehydrogenase family superfamily [1.1.1.14]
ORF03086	6171 & 6172	ribose ABC transporter, permease protein
ORF03087	6173 & 6174	D-xylose ABC transporter, ATP-binding protein
ORF03088	6175 & 6176	ribose ABC transporter, periplasmic ribose-binding protein, putative
ORF03089	6177 & 6178	TPR Domain domain protein
ORF03090	6179 & 6180	ROK family protein domain protein
ORF03091	6181 & 6182	serine hydroxymethyltransferase (glyA) [2.1.2.1]
ORF03092	6183 & 6184	dihydropteridine reductase (NOD) [1.5.1.34]
ORF03093	6185 & 6186	Nitrogen regulatory protein P-II
ORF03094	6187 & 6188	transcriptional regulatory protein
ORF03095	6189 & 6190	unnamed protein product
ORF03096	6191 & 6192	two-component system sensor kinase
ORF03097	6193 & 6194	phosphoribosylformylglycinamidine synthase (purL) [6.3.5.3]
ORF03098	6195 & 6196	transglycosylase, Slt family
ORF03099	6197 & 6198	tRNA-specific adenosine deaminase [3.5.4.-]
ORF03100	6199 & 6200	HAD superfamily (subfamily IF) hydrolase, YfhB (yfhb)
ORF03101	6201 & 6202	Transcriptional regulator (membrane)
ORF03102	6203 & 6204	NapF protein (fdx)
ORF03103	6205 & 6206	holo-(acyl-carrier-protein) synthase (acpS) [2.7.8.7]
ORF03104	6207 & 6208	pyridoxal phosphate biosynthetic protein PdxJ (pdxJ)
ORF03105	6209 & 6210	DNA repair protein RecO (recO)
ORF03106	6211 & 6212	GTP-binding protein Era (era)
ORF03107	6213 & 6214	ribonuclease III (rnc) [3.1.26.3]
ORF03108	6215 & 6216	signal peptidase I [similarity] (lep) [3.4.21.89]
ORF03109	6217 & 6218	GTP-binding protein LepA (lepA)
ORF03110	6219 & 6220	Sigma-E factor Regulatory protein rseC
ORF03111	6221 & 6222	Sigma-E factor Regulatory protein rseB precursor (rseB)
ORF03112	6223 & 6224	sigma-E factor, negative regulatory protein
ORF03113	6225 & 6226	RNA polymerase sigma E (SIGMA)
ORF03114	6227 & 6228	hypothetical protein
ORF03115	6229 & 6230	unnamed protein product
ORF03116	6231 & 6232	L-aspartate oxidase (nadB) [1.4.3.16]

ORF03117	6233 & 6234	ATP-dependent RNA helicase (srmB)
ORF03118	6235 & 6236	similar to [SwissProt Accession Number P33634]
ORF03119	6237 & 6238	translocator protein, LysE family superfamily
ORF03120	6239 & 6240	Protein yfiD
ORF03121	6241 & 6242	uracil-DNA glycosylase (ung) [3.2.2.-]
ORF03122	6243 & 6244	similar to [SwissProt Accession Number P33635] start codon is not identified yet
ORF03123	6245 & 6246	hypothetical protein
ORF03124	6247 & 6248	thioredoxin (trx)
ORF03125	6249 & 6250	DTW domain protein
ORF03126	6251 & 6252	Acyl-CoA synthetase (NDP forming)
ORF03127	6253 & 6254	CDP-DIACYLGLYCEROL--SERINE O-PHOSPHATIDYLTRANSFERASE (EC 2.7.8.8) (PHOSPHATIDYLSERINE SYNTHASE). [2.7.8.8]
ORF03128	6255 & 6256	lipoprotein, putative
ORF03129	6257 & 6258	Alpha-ketoglutarate permease
ORF03130	6259 & 6260	transposase
ORF03131	6261 & 6262	transposase
ORF03132	6263 & 6264	transposase
ORF03133	6265 & 6266	hypothetical
ORF03134	6267 & 6268	hypothetical protein
ORF03135	6269 & 6270	heat shock protein [3.4.21.-]
ORF03136	6271 & 6272	conserved hypothetical protein TIGR00726
ORF03137	6273 & 6274	ribosomal large subunit pseudouridine synthase D (sfhB) [4.2.1.70]
ORF03138	6275 & 6276	unkown
ORF03139	6277 & 6278	ribosomal subunit interface protein (yfiA)
ORF03140	6279 & 6280	P-protein (PDT) [5.4.99.5]
ORF03141	6281 & 6282	T-protein (PDH) [5.4.99.5]
ORF03142	6283 & 6284	phospho-2-dehydro-3-deoxyheptonate aldolase [2.5.1.54]
ORF03143	6285 & 6286	lipoprotein, putative
ORF03144	6287 & 6288	conserved hypothetical protein
ORF03145	6289 & 6290	similar to [SwissProt Accession Number P46139]
ORF03146	6291 & 6292	unnamed protein product; unidentified reading frame (16K polypeptide) (aa 1-127)
ORF03147	6293 & 6294	ribosomal protein L19 (rplS)
ORF03148	6295 & 6296	tRNA (guanine-N1)-methyltransferase (trmD) [2.1.1.31]
ORF03149	6297 & 6298	16S rRNA processing protein RimM (rimM)
ORF03150	6299 & 6300	30S ribosomal protein S16 (rpS16)
ORF03151	6301 & 6302	signal recognition particle protein (ffh)
ORF03152	6303 & 6304	CorE
ORF03153	6305 & 6306	unnamed protein product
ORF03154	6307 & 6308	co-chaperone GrpE (grpE)
ORF03155	6309 & 6310	NAD+ kinase [2.7.1.23]
ORF03156	6311 & 6312	hypothetical protein
ORF03157	6313 & 6314	DNA repair protein RecN (recN)
ORF03158	6315 & 6316	Small protein A precursor
ORF03159	6317 & 6318	Protein yfjF
ORF03160	6319 & 6320	Streptomyces cyclase-dehydrase family
ORF03161	6321 & 6322	SsrA-binding protein (smpB)
ORF03162	6323 & 6324	hypothetical protein
ORF03163	6325 & 6326	conserved hypothetical protein
ORF03164	6327 & 6328	DinI-like protein Z3916-ECs3483 (AF175466)
ORF03165	6329 & 6330	T4-exclusion protein stimulator gIBEGs
ORF03166	6331 & 6332	ycfE protein (fragment)
ORF03167	6333 & 6334	unnamed protein product; unidentified reading frame P-293

ORF03168	6335 & 6336	Heat shock protein [3.4.21.-]
ORF03169	6337 & 6338	heat shock protein [3.4.21.-]
ORF03170	6339 & 6340	conserved hypothetical protein
ORF03171	6341 & 6342	Sb36
ORF03172	6343 & 6344	conserved hypothetical protein
ORF03173	6345 & 6346	hypothetical protein
ORF03174	6347 & 6348	conserved hypothetical protein
ORF03175	6349 & 6350	unnamed protein product
ORF03176	6351 & 6352	hypothetical protein
ORF03177	6353 & 6354	gab protein
ORF03178	6355 & 6356	predicted dehydrogenase
ORF03179	6357 & 6358	Succinate-semialdehyde dehydrogenase [NADP+] [1.2.1.16]
ORF03180	6359 & 6360	4-aminobutyrate transaminase (gabT) [2.6.1.19]
ORF03181	6361 & 6362	GABA permease (gabP)
ORF03182	6363 & 6364	transcriptional regulator, GntR family, putative
ORF03183	6365 & 6366	Putative phospholipid-binding domain family
ORF03184	6367 & 6368	Hypothetical UPF0057 protein yqaE-related protein
ORF03185	6369 & 6370	transcriptional regulator, ArsR family (AJ001934)
ORF03186	6371 & 6372	rhodanese family protein , putative
ORF03187	6373 & 6374	DNA-binding protein stpA
ORF03188	6375 & 6376	Protein of unknown function (DUF1144) superfamily
ORF03189	6377 & 6378	similar to [SwissProt Accession Number P36931] start codon is not identified yet
ORF03190	6379 & 6380	unnamed protein product; ORFA
ORF03191	6381 & 6382	GntR-family transcriptional regulator (X78503)
ORF03192	6383 & 6384	Uncharacterized ACR
ORF03193	6385 & 6386	nrdH-related protein
ORF03194	6387 & 6388	nrdI protein (nrdI)
ORF03195	6389 & 6390	ribonucleoside-diphosphate reductase alpha chain
ORF03196	6391 & 6392	ribonucleoside-diphosphate reductase, beta subunit [1.17.4.1]
ORF03197	6393 & 6394	ATP-binding component of transport system for glycine, betaine and proline (atp_bind)
ORF03198	6395 & 6396	Glycine betaine-L-proline transport system permease protein proW (membrane)
ORF03199	6397 & 6398	high-affinity glycine betaine - proline transport system
ORF03200	6399 & 6400	major facilitator family transporter (permease)
ORF03201	6401 & 6402	AzlC family protein, putative
ORF03202	6403 & 6404	YgaH protein
ORF03203	6405 & 6406	Transcriptional repressor mprA (EmrR protein)
ORF03204	6407 & 6408	Multidrug resistance protein A
ORF03205	6409 & 6410	Multidrug resistance protein B
ORF03206	6411 & 6412	conserved hypothetical protein
ORF03207	6413 & 6414	conserved hypothetical protein
ORF03208	6415 & 6416	autoinducer-2 production protein LuxS (luxS)
ORF03209	6417 & 6418	glutamate--cysteine ligase (gshA) [6.3.2.2]
ORF03210	6419 & 6420	gamma-glutamate-cysteine ligase (GCS)
ORF03211	6421 & 6422	conserved hypothetical protein
ORF03212	6423 & 6424	CbbY family protein VCA0662 (pgp)
ORF03213	6425 & 6426	carbon storage regulator (csrA)
ORF03214	6427 & 6428	alanyl-tRNA synthetase (alaS) [6.1.1.7]
ORF03215	6429 & 6430	Regulatory protein recX (oraA protein) (recX)
ORF03216	6431 & 6432	recA protein (recA)
ORF03217	6433 & 6434	Protein ygaD
ORF03218	6435 & 6436	Membrane-bound lytic murein transglycosylase B precursor

ORF03219	6437 & 6438	PTS SYSTEM, GLUCITOL-SORBITOL-SPECIFIC IIBC COMPONENT (EIIBC-GUT) (GLUCITOL-SORBITOL-PERMEASE IIBC COMPONENT) (PHOSPHOTRANSFERASE ENZYME II, BC COMPONENT) (EC 2.7.1.69) (EII-GUT) [2.7.1.69]
ORF03220	6439 & 6440	PTS SYSTEM, GLUCITOL-SORBITOL-SPECIFIC IIBC COMPONENT (EIIBC-GUT) (GLUCITOL-SORBITOL-PERMEASE IIBC COMPONENT) (PHOSPHOTRANSFERASE ENZYME II, BC COMPONENT) (EC 2.7.1.69) (EII-GUT) [2.7.1.69]
ORF03221	6441 & 6442	PTS enzyme III glucitol [2.7.1.69]
ORF03222	6443 & 6444	3-oxoacyl-(acyl-carrier-protein) reductase (sorbitol) [1.1.1.140]
ORF03223	6445 & 6446	Glucitol operon activator protein (gutM)
ORF03224	6447 & 6448	Glucitol operon repressor (srl)
ORF03225	6449 & 6450	GutQ protein
ORF03226	6451 & 6452	ygaA protein (fhlA)
ORF03227	6453 & 6454	Anaerobic nitric oxide reductase flavorubredoxin (FlRd) (FlavoRb) (fprA) [1.-.-.-]
ORF03228	6455 & 6456	Nitric oxide reductase FlRd-NAD(+) reductase(Flavorubredoxin reductase) (FlRd-reductase) (FlavoRb reductase) (FAD) [1.18.1.-]
ORF03229	6457 & 6458	[NiFe] hydrogenase maturation protein HypF (hypF)
ORF03230	6459 & 6460	Electron transport protein hydN
ORF03231	6461 & 6462	hypothetical protein
ORF03232	6463 & 6464	ascBF operon repressor
ORF03233	6465 & 6466	PTS system enzyme II ABC (asc) [2.7.1.69]
ORF03234	6467 & 6468	6-phospho-beta-glucosidase [3.2.1.86]
ORF03235	6469 & 6470	unnamed protein product
ORF03236	6471 & 6472	conserved hypothetical protein
ORF03237	6473 & 6474	hydrogenase maturation protease HycI
ORF03238	6475 & 6476	Formate hydrogenlyase maturation protein hycH (HycE) [1.-.-.-]
ORF03239	6477 & 6478	Formate hydrogenlyase subunit 7 [1.18.99.1]
ORF03240	6479 & 6480	Formate hydrogenlyase subunit 6 [1.18.99.1]
ORF03241	6481 & 6482	hydrogenase 3 large subunit [1.18.99.1]
ORF03242	6483 & 6484	Formate hydrogenlyase subunit 4 (hycD) [1.18.99.1]
ORF03243	6485 & 6486	Formate hydrogenlyase subunit 3 (FHL subunit 3) (Hydrogenase-3component C) [1.18.99.1]
ORF03244	6487 & 6488	formate hydrogenlyase subunit-7 component B (FHL)
ORF03245	6489 & 6490	Formate hydrogenlyase regulatory protein hycA
ORF03246	6491 & 6492	hydrogenase nickel insertion protein HypA (hypA)
ORF03247	6493 & 6494	hydrogenase accessory protein HypB
ORF03248	6495 & 6496	hydrogenase assembly chaperone HypC-HupF (hypC)
ORF03249	6497 & 6498	hydrogenase expression-formation protein HypD (hypD)
ORF03250	6499 & 6500	hydrogenase expression-formation protein HypE (hypE)
ORF03251	6501 & 6502	Formate hydrogenlyase transcriptional activator
ORF03252	6503 & 6504	Potential molybdenum-pterin-binding-protein
ORF03253	6505 & 6506	conserved hypothetical protein
ORF03254	6507 & 6508	DNA mismatch repair protein MutS (mutS)
ORF03255	6509 & 6510	Serine-threonine protein phosphatase 2 [3.1.3.16]
ORF03256	6511 & 6512	Transcriptional regulator of sugar metabolism
ORF03257	6513 & 6514	3-hydroxyisobutyrate dehydrogenase [1.1.-.-]
ORF03258	6515 & 6516	tRNA synthase-like protein
ORF03259	6517 & 6518	L-fuculose-1-phosphate aldolase-like protein (fucA) [4.1.2.17]
ORF03260	6519 & 6520	Hfi protein [5.3.1.22]
ORF03261	6521 & 6522	gluconate permease
ORF03262	6523 & 6524	metallo-beta-lactamase superfamily domain protein

ORF03263	6525 & 6526	tryptophan repressor binding protein
ORF03264	6527 & 6528	sigma factor RpoS (sigma38)
ORF03265	6529 & 6530	sigma factor RpoS (sigma38)
ORF03266	6531 & 6532	Lipoprotein nlpD precursor
ORF03267	6533 & 6534	protein-L-isoaspartate O-methyltransferase (pcm) [2.1.1.77]
ORF03268	6535 & 6536	acid phosphatase SurE (surE) [3.1.3.2]
ORF03269	6537 & 6538	conserved hypothetical protein TIGR00094
ORF03270	6539 & 6540	2C-methyl-D-erythritol 2,4-cyclodiphosphate synthase (ispF) [4.6.1.12]
ORF03271	6541 & 6542	2-C-methyl-D-erythritol 4-phosphate cytidylyltransferase (ispD) [2.7.7.60]
ORF03272	6543 & 6544	Cell division protein ftsB
ORF03273	6545 & 6546	YgbE
ORF03274	6547 & 6548	adenylylsulfate kinase (cysC) [2.7.1.25]
ORF03275	6549 & 6550	Sulfate adenylyltransferase subunit 1 (Sulfate adenylatetransferase) (SAT) (ATP-sulfurylase large subunit) (SAT) [2.7.7.4]
ORF03276	6551 & 6552	Sulfate adenylyltransferase subunit 2 (Sulfate adenylatetransferase) (SAT) (ATP-sulfurylase small subunit) (SAT) [2.7.7.4]
ORF03277	6553 & 6554	hypothetical protein
ORF03278	6555 & 6556	Alkaline phosphatase isozyme conversion protein precursor [3.4.11.-]
ORF03279	6557 & 6558	Hok-gef family superfamily
ORF03280	6559 & 6560	3-phosphoadenosine 5-phosphosulfate reductase
ORF03281	6561 & 6562	sulfite reductase (NADPH) hemoprotein, beta subunit (cysI) [1.8.1.2]
ORF03282	6563 & 6564	sulfite reductase [NADPH] flavoprotein, alpha chain [1.8.1.2]
ORF03283	6565 & 6566	6-pyruvoyl-tetrahydropterin synthase
ORF03284	6567 & 6568	Probable electron transfer flavoprotein-quinone oxidoreductase ygcN
ORF03285	6569 & 6570	Ferredoxin-like protein ygcO
ORF03286	6571 & 6572	glycerol uptake operon antiterminator regulatory protein, putative
ORF03287	6573 & 6574	electron transfer flavoprotein, alpha subunit subfamily (etfA)
ORF03288	6575 & 6576	putative transport protein
ORF03289	6577 & 6578	sugar transporter, putative
ORF03290	6579 & 6580	alkyl-dihydroxyacetonephosphate synthase, putative
ORF03291	6581 & 6582	1.-.-.- [1.1.1.-]
ORF03292	6583 & 6584	Major Facilitator Superfamily subfamily
ORF03293	6585 & 6586	sugar kinase, FGGY family, putative [2.7.1.17]
ORF03294	6587 & 6588	radical activating enzyme
ORF03295	6589 & 6590	radical activating enzyme
ORF03296	6591 & 6592	LemA family superfamily
ORF03297	6593 & 6594	glycine rich protein
ORF03298	6595 & 6596	conserved hypothetical protein
ORF03299	6597 & 6598	Domain of unknown function (DUF477) family
ORF03300	6599 & 6600	glycine rich protein
ORF03301	6601 & 6602	enolase (eno) [4.2.1.11]
ORF03302	6603 & 6604	CTP synthase (pyrG) [6.3.4.2]
ORF03303	6605 & 6606	MazG protein (mazG)
ORF03304	6607 & 6608	PemK-like protein 1 (MazF protein) (AF027767)
ORF03305	6609 & 6610	PemI-like protein 1 (MazE protein)
ORF03306	6611 & 6612	GTP pyrophosphokinase (ATP:GTP 3'-pyrophosphotransferase)(ppGpp synthetase I) ((p)ppGpp synthetase) (relA) [2.7.6.5]
ORF03307	6613 & 6614	23S rRNA (uracil-5-)-methyltransferase RumA (rumA) [2.1.1.-]
ORF03308	6615 & 6616	Sensor protein barA [2.7.3.-]
ORF03309	6617 & 6618	hypothetical protein
ORF03310	6619 & 6620	glucarate dehydratase [4.2.1.40]
ORF03311	6621 & 6622	glucarate dehydratase [4.2.1.-]

ORF03312	6623 & 6624	MFS transporter, phthalate permease family
ORF03313	6625 & 6626	Exoenzyme regulation regulon (mioC)
ORF03314	6627 & 6628	RNA pseudouridylate synthase family protein [4.2.1.70]
ORF03315	6629 & 6630	tRNA pseudouridine synthase C (Pseudouridylate synthase)(Uracil hydrolyase) [4.2.1.70]
ORF03316	6631 & 6632	interacts with secY
ORF03317	6633 & 6634	hypothetical protein
ORF03318	6635 & 6636	GTP cyclohydrolase I-like protein
ORF03319	6637 & 6638	Predicted Rossmann fold nucleotide-binding protein
ORF03320	6639 & 6640	Serine transporter
ORF03321	6641 & 6642	L-serine ammonia-lyase (sdaA) [4.3.1.17]
ORF03322	6643 & 6644	exodeoxyribonuclease IX
ORF03323	6645 & 6646	Lactaldehyde reductase [1.1.1.77]
ORF03324	6647 & 6648	L-fuculose phosphate aldolase (fucA) [4.1.2.17]
ORF03325	6649 & 6650	conserved hypothetical protein
ORF03326	6651 & 6652	L-fucose permease (fucP)
ORF03327	6653 & 6654	L-fucose isomerase (fucI) [5.3.1.25]
ORF03328	6655 & 6656	L-fuculokinase (L-fuculose kinase) (fucK) [2.7.1.51]
ORF03329	6657 & 6658	Fucose operon fucU protein (fucU)
ORF03330	6659 & 6660	hypothetical protein
ORF03331	6661 & 6662	L-fucose operon activator
ORF03332	6663 & 6664	SAM-dependent methyltransferase-like protein
ORF03333	6665 & 6666	Uncharacterized small membrane protein
ORF03334	6667 & 6668	transcriptional regulator, LysR family (gcvA)
ORF03335	6669 & 6670	Bacterial protein of unknown function (DUF903) superfamily
ORF03336	6671 & 6672	Cysteine sulfinate desulfinase
ORF03337	6673 & 6674	Fe-S metabolism associated domain subfamily
ORF03338	6675 & 6676	Dinucleotide-utilizing enzymes involved in molybdopterin and thiamine biosynthesis family 1
ORF03339	6677 & 6678	Membrane-bound lytic murein transglycosylase A precursor
ORF03340	6679 & 6680	Protein of unknown function (DUF770) superfamily
ORF03341	6681 & 6682	Aec18
ORF03342	6683 & 6684	Bacterial protein of unknown function (DUF876) superfamily
ORF03343	6685 & 6686	Possibly conserved membrane protein
ORF03344	6687 & 6688	unnamed protein product
ORF03345	6689 & 6690	Secreted protein Hcp
ORF03346	6691 & 6692	ClpB protein
ORF03347	6693 & 6694	Rhs element Vgr protein subfamily, putative
ORF03348	6695 & 6696	unnamed protein product; Similar to unknown protein
ORF03349	6697 & 6698	unnamed protein product; Highly similar to unknown protein of Photorhabdus. Putative secreted protein, putative
ORF03350	6699 & 6700	unnamed protein product
ORF03351	6701 & 6702	unnamed protein product
ORF03352	6703 & 6704	ImpA-related N-terminal family
ORF03353	6705 & 6706	conserved hypothetical protein
ORF03354	6707 & 6708	hypothetical protein
ORF03355	6709 & 6710	Bacterial protein of unknown function (DUF879) superfamily
ORF03356	6711 & 6712	Protein of unknown function (DUF1305) superfamily
ORF03357	6713 & 6714	lipoprotein, putative
ORF03358	6715 & 6716	Protein of unknown function (DUF1316) subfamily
ORF03359	6717 & 6718	conserved hypothetical protein
ORF03360	6719 & 6720	ImpA-related N-terminal family

ORF03361	6721 & 6722	2-hydroxyacid dehydrogenase (serA)
ORF03362	6723 & 6724	Phosphosugar isomerase
ORF03363	6725 & 6726	Beta-cystathionase
ORF03364	6727 & 6728	PTS system, IIBC components , putative [2.7.1.69]
ORF03365	6729 & 6730	Antiterminator
ORF03366	6731 & 6732	N-acetylmuramoyl-L-alanine amidase amiC precursor [3.5.1.28]
ORF03367	6733 & 6734	amino-acid N-acetyltransferase (argA) [2.3.1.1]
ORF03368	6735 & 6736	exodeoxyribonuclease V, alpha subunit (recD) [3.1.11.5]
ORF03369	6737 & 6738	exodeoxyribonuclease V, beta subunit (recB) [3.1.11.5]
ORF03370	6739 & 6740	Protease III precursor (Pitrilysin) (Protease pi) (pitrilysin) [3.4.24.55]
ORF03371	6741 & 6742	exodeoxyribonuclease V, gamma subunit (recC) [3.1.11.5]
ORF03372	6743 & 6744	Prepilin peptidase dependent protein C precursor
ORF03373	6745 & 6746	conserved hypothetical protein
ORF03374	6747 & 6748	unnamed protein product; URF1 (aa 1-267)
ORF03375	6749 & 6750	Prepilin peptidase dependent protein A precursor
ORF03376	6751 & 6752	thymidylate synthase (thyA) [2.1.1.45]
ORF03377	6753 & 6754	prolipoprotein diacylglyceryl transferase (lgt) [2.4.99.-]
ORF03378	6755 & 6756	Phosphoenolpyruvate-protein phosphotransferase ptsP (Ntr) [2.7.3.9]
ORF03379	6757 & 6758	NTP pyrophosphohydrolases including oxidative damage repair enzymes
ORF03380	6759 & 6760	DNA mismatch repair endonuclease mutH (mutH)
ORF03381	6761 & 6762	TerC protein
ORF03382	6763 & 6764	lipoprotein
ORF03383	6765 & 6766	Tas protein
ORF03384	6767 & 6768	unnamed protein product
ORF03385	6769 & 6770	AAS bifunctional protein
ORF03386	6771 & 6772	Galactose operon repressor
ORF03387	6773 & 6774	diaminopimelate decarboxylase (lysA) [4.1.1.20]
ORF03388	6775 & 6776	aspartate racemase subfamily [5.1.1.13]
ORF03389	6777 & 6778	Transcriptional activator protein lysR
ORF03390	6779 & 6780	Arabinose-proton symporter
ORF03391	6781 & 6782	2-deoxy-D-gluconate 3-dehydrogenase (kduD) [1.1.1.125]
ORF03392	6783 & 6784	4-deoxy-L-threo-5-hexosulose-uronate ketol-isomerase
ORF03393	6785 & 6786	Probable acetyl-CoA acetyltransferase
ORF03394	6787 & 6788	serine transporter
ORF03395	6789 & 6790	possible lipoprotein
ORF03396	6791 & 6792	aldehyde oxidoreductase, putative [1.1.1.204]
ORF03397	6793 & 6794	Xanthine dehydrogenase, FAD binding subunit (cutB) [1.1.1.204]
ORF03398	6795 & 6796	small chain CO dehydrogenase (cutC)
ORF03399	6797 & 6798	signal-transduction and transcriptional-control protein
ORF03400	6799 & 6800	hypothetical protein
ORF03401	6801 & 6802	Aspartate-ornithine carbamoyltransferase, Asp-Orn binding domain family
ORF03402	6803 & 6804	threonine dehydratase biosynthetic [4.3.1.15]
ORF03403	6805 & 6806	acetylornithine deacetylase, putative
ORF03404	6807 & 6808	dihydropyrimidinase (hydA) [3.5.2.2]
ORF03405	6809 & 6810	carbamate kinase (arcC) [2.7.2.2]
ORF03406	6811 & 6812	xanthine dehydrogenase accessory factor, putative subfamily, putative
ORF03407	6813 & 6814	conserved hypothetical protein
ORF03408	6815 & 6816	hypotehtical ygfJ
ORF03409	6817 & 6818	oxidoreductase, pyridine nucleotide-disulfide family
ORF03410	6819 & 6820	chlorohydrolase family protein, putative
ORF03411	6821 & 6822	FAD binding domain in molybdopterin dehydrogenase protein
ORF03412	6823 & 6824	aldehyde oxidoreductase, putative [1.-.-.-]

ORF03413	6825 & 6826	xanthine-uracil permease family protein
ORF03414	6827 & 6828	Guanine deaminase
ORF03415	6829 & 6830	xanthine-uracil permease family protein
ORF03416	6831 & 6832	Electron transport protein hydN
ORF03417	6833 & 6834	anaerobically expressed oxidoreductase (GltD) [1.4.1.13]
ORF03418	6835 & 6836	xanthine permease
ORF03419	6837 & 6838	isopentenyl-diphosphate delta-isomerase, type 1 (idi) [5.3.3.2]
ORF03420	6839 & 6840	lysyl-tRNA synthetase (lysS) [6.1.1.6]
ORF03421	6841 & 6842	peptide chain release factor 2 (prfB)
ORF03422	6843 & 6844	single-stranded-DNA-specific exonuclease RecJ (recJ) [3.1.-.-]
ORF03423	6845 & 6846	Thiol:disulfide interchange protein dsbC precursor (DsbC) [5.3.4.1]
ORF03424	6847 & 6848	tyrosine recombinase XerD (xerD)
ORF03425	6849 & 6850	flavodoxin
ORF03426	6851 & 6852	unnamed protein product
ORF03427	6853 & 6854	Uncharacterized conserved protein
ORF03428	6855 & 6856	Predicted aminomethyltransferase
ORF03429	6857 & 6858	similar to hemolysin III homolog
ORF03430	6859 & 6860	UPF0267 protein
ORF03431	6861 & 6862	6-phospho-beta-glucosidase
ORF03432	6863 & 6864	glycine dehydrogenase (gcvP) [1.4.4.2]
ORF03433	6865 & 6866	glycine cleavage system H protein (gcvH)
ORF03434	6867 & 6868	glycine cleavage system T protein (gcvT) [2.1.2.10]
ORF03435	6869 & 6870	Protein visC [1.-.-.-]
ORF03436	6871 & 6872	2-polyprenyl-6-methoxyphenol 4-hydroxylase (ubiH) [1.14.13.-]
ORF03437	6873 & 6874	Xaa-Pro aminopeptidase (APP-II) [3.4.11.9]
ORF03438	6875 & 6876	yecA family protein subfamily
ORF03439	6877 & 6878	Family of unknown function (DUF710) superfamily
ORF03440	6879 & 6880	5-formyltetrahydrofolate cyclo-ligase family protein, putative
ORF03441	6881 & 6882	D-3-phosphoglycerate dehydrogenase [1.1.1.95]
ORF03442	6883 & 6884	ribose 5-phosphate isomerase A (rpiA) [5.3.1.6]
ORF03443	6885 & 6886	conserved hypothetical protein
ORF03444	6887 & 6888	Chromosome initiation inhibitor
ORF03445	6889 & 6890	unnamed protein product; sbm orf (MCM)
ORF03446	6891 & 6892	putative transcriptional regulator LYSR-type
ORF03447	6893 & 6894	lpqG, putative
ORF03448	6895 & 6896	possible membrane transport protein
ORF03449	6897 & 6898	small-conductance mechanosensitive channel
ORF03450	6899 & 6900	fructose-bisphosphate aldolase, class II (fbaA) [4.1.2.13]
ORF03451	6901 & 6902	phosphoglycerate kinase (pgk) [2.7.2.3]
ORF03452	6903 & 6904	D-erythrose-4-phosphate dehydrogenase (epd) [1.2.1.-]
ORF03453	6905 & 6906	hypothetical protein
ORF03454	6907 & 6908	Domain of unknown function (DUF296) family
ORF03455	6909 & 6910	conserved hypothetical protein
ORF03456	6911 & 6912	conserved hypothetical protein
ORF03457	6913 & 6914	ABC transporter, ATP-binding protein
ORF03458	6915 & 6916	kinase-related protein
ORF03459	6917 & 6918	Cobalt transport ATP-binding protein cbiO
ORF03460	6919 & 6920	unnamed protein product; ORF2 (AA 1-133)
ORF03461	6921 & 6922	fructose-1,6-bisphosphatase, class II
ORF03462	6923 & 6924	Putative oxidoreductase
ORF03463	6925 & 6926	PTS system, mannitol (Cryptic) [2.7.1.69]

ORF03464	6927 & 6928	PTS system, mannitol (Cryptic)-specific IIA component (EIIA-(C)Mtl)(Mannitol (Cryptic)-permease IIA component) (Phosphotransferase enzymeII, A component) (Cryptic) [2.7.1.69]
ORF03465	6929 & 6930	putative serine protease
ORF03466	6931 & 6932	transketolase (tkt) [2.2.1.1]
ORF03467	6933 & 6934	Putative metalloprotease yggG
ORF03468	6935 & 6936	agmatinase, putative [3.5.3.11]
ORF03469	6937 & 6938	lipoprotein, putative
ORF03470	6939 & 6940	arginine decarboxylase (speA) [4.1.1.19]
ORF03471	6941 & 6942	conserved hypothetical protein
ORF03472	6943 & 6944	conserved hypothetical protein
ORF03473	6945 & 6946	S-adenosylmethionine synthetase (metK) [2.5.1.6]
ORF03474	6947 & 6948	Galactose-proton symporter
ORF03475	6949 & 6950	Protein sprT
ORF03476	6951 & 6952	Endonuclease I precursor
ORF03477	6953 & 6954	conserved hypothetical protein TIGR00046
ORF03478	6955 & 6956	glutathione synthase (gshB) [6.3.2.3]
ORF03479	6957 & 6958	Uncharacterized ACR, COG1678
ORF03480	6959 & 6960	conserved hypothetical protein TIGR00250
ORF03481	6961 & 6962	Predicted ATPases involved in pili biogenesis, PilT homologs
ORF03482	6963 & 6964	conserved hypothetical protein TIGR00044
ORF03483	6965 & 6966	Predicted integral membrane protein
ORF03484	6967 & 6968	conserved hypothetical protein TIGR00251
ORF03485	6969 & 6970	non-canonical purine NTP pyrophosphatase, rdgB-HAM1 family (rdgB)
ORF03486	6971 & 6972	oxygen-independent coproporphyrinogen III oxidase, putative
ORF03487	6973 & 6974	Protein of unknown function (DUF1202) superfamily
ORF03488	6975 & 6976	L-asparaginase II (ansB) [3.5.1.1]
ORF03489	6977 & 6978	conserved hypothetical protein
ORF03490	6979 & 6980	conserved hypothetical protein
ORF03491	6981 & 6982	Protein
ORF03492	6983 & 6984	tRNA (guanine-N(7)-)-methyltransferase (tRNA(m7G46)-methyltransferase) [2.1.1.33]
ORF03493	6985 & 6986	A-G-specific adenine glycosylase
ORF03494	6987 & 6988	Protein yggX
ORF03495	6989 & 6990	yggZ protein (mltC) [3.2.1.-]
ORF03496	6991 & 6992	nucleoside permease NupG
ORF03497	6993 & 6994	ornithine decarboxylase isozyme (speC) [4.1.1.17]
ORF03498	6995 & 6996	integral membrane protein
ORF03499	6997 & 6998	transposase, truncated
ORF03500	6999 & 7000	KpsF
ORF03501	7001 & 7002	Capsule polysaccharide export inner-membrane protein kpsE
ORF03502	7003 & 7004	polysaccharide biosynthesis protein, putative
ORF03503	7005 & 7006	3-deoxy-D-manno-octulosonate cytidylyltransferase (kdsB) [2.7.7.38]
ORF03504	7007 & 7008	capsule polysaccharide export protein KpsC
ORF03505	7009 & 7010	KpsS protein
ORF03506	7011 & 7012	polysialic acid capsule biosynthesis protein SiaD, truncation; disrupted by foreign ermC, putative [2.4.-.-]
ORF03507	7013 & 7014	NeuE protein
ORF03508	7015 & 7016	UDP-N-acetylglucosamine 2-epimerase [5.1.3.14]
ORF03509	7017 & 7018	acylneuraminate cytidylyltransferase, putative [2.7.7.43]
ORF03510	7019 & 7020	neuB protein [4.1.3.-]
ORF03511	7021 & 7022	Polysialic acid transport ATP-binding protein kpsT [3.6.3.38]

ORF03512	7023 & 7024	Polysialic acid transport protein kpsM
ORF03513	7025 & 7026	Putative general secretion pathway protein M-type yghD
ORF03514	7027 & 7028	general secretion pathway protein L (gspL)
ORF03515	7029 & 7030	General secretion pathway protein K (gspK)
ORF03516	7031 & 7032	general secretion pathway protein J (gspJ)
ORF03517	7033 & 7034	general secretion pathway protein I (gspI)
ORF03518	7035 & 7036	GspH, hypothetical type II secretion protein
ORF03519	7037 & 7038	general secretion pathway protein G (gspG)
ORF03520	7039 & 7040	general secretion pathway protein F (gspF)
ORF03521	7041 & 7042	general secretion pathway protein E (GSP)
ORF03522	7043 & 7044	type II secretory pathway, component EpsD
ORF03523	7045 & 7046	general secretion pathway protein C (gspC)
ORF03524	7047 & 7048	YghG protein
ORF03525	7049 & 7050	secretion protein b2972 [3.4.23.43]
ORF03526	7051 & 7052	Accessory colonization factor AcfD precursor
ORF03527	7053 & 7054	Glycolate permease glcA
ORF03528	7055 & 7056	malate synthase G (glcB) [2.3.3.9]
ORF03529	7057 & 7058	glcG protein
ORF03530	7059 & 7060	glycolate oxidase subunits GlcE and GlcF (Fe-S) [1.1.3.15]
ORF03531	7061 & 7062	glycolate oxidase subunits GlcE and GlcF
ORF03532	7063 & 7064	glycolate oxidase, subunit GlcD (glcD)
ORF03533	7065 & 7066	Glc operon transcriptional activator
ORF03534	7067 & 7068	conserved hypothetical protein
ORF03535	7069 & 7070	acyl-CoA synthase
ORF03536	7071 & 7072	conserved hypothetical protein
ORF03537	7073 & 7074	Phosphopantetheine attachment site (ACP)
ORF03538	7075 & 7076	8-amino-7-oxononanoate synthase
ORF03539	7077 & 7078	Predicted permease YjgP-YjgQ family superfamily
ORF03540	7079 & 7080	Predicted permease YjgP-YjgQ family superfamily
ORF03541	7081 & 7082	conserved hypothetical protein YtfJ-family, TIGR01626
ORF03542	7083 & 7084	conserved hypothetical protein
ORF03543	7085 & 7086	Polysaccharide biosynthesis protein domain protein
ORF03544	7087 & 7088	Hypothetical ATP-binding protein yghR
ORF03545	7089 & 7090	Hypothetical ATP-binding protein yghS
ORF03546	7091 & 7092	hypothetical protein
ORF03547	7093 & 7094	Hypothetical ATP-binding protein yghT
ORF03548	7095 & 7096	low-affinity phosphate transport protein
ORF03549	7097 & 7098	Glutathionylspermidine synthase
ORF03550	7099 & 7100	Hypothetical GST-like protein yghU
ORF03551	7101 & 7102	hydrogenase assembly chaperone HypC-HupF (hypC)
ORF03552	7103 & 7104	hydrogenase nickel insertion protein HypA (hypA)
ORF03553	7105 & 7106	Hydrogenase-2 operon protein hybE
ORF03554	7107 & 7108	hydrogenase expression-formation protein
ORF03555	7109 & 7110	hydrogenase-2 large subunit HybC [1.18.99.1]
ORF03556	7111 & 7112	cytochrome Ni-Fe component of hydrogenase-2
ORF03557	7113 & 7114	Hydrogenase-2 operon protein hybA precursor
ORF03558	7115 & 7116	Hydrogenase-2 small chain precursor (NiFe hydrogenase)(Membrane-bound hydrogenase 2 small subunit) (HYD2) (hydA) [1.12.99.6]
ORF03559	7117 & 7118	conserved hypothetical protein
ORF03560	7119 & 7120	dienelactone hydrolase family protein
ORF03561	7121 & 7122	oxidoreductase, aldo-keto reductase family
ORF03562	7123 & 7124	conserved hypothetical protein TIGR00645

ORF03563	7125 & 7126	oxidoreductase, short chain dehydrogenase-reductase family [1.-.-.-]
ORF03564	7127 & 7128	Biopolymer transport exbD protein
ORF03565	7129 & 7130	biopolymer transport ExbB protein (uptake)
ORF03566	7131 & 7132	cystathionine beta-lyase (metC) [4.4.1.8]
ORF03567	7133 & 7134	unnamed protein product; Similar to DedA-family integral membrane protein YghB of Escherichia coli
ORF03568	7135 & 7136	transcriptional regulator, AraC family
ORF03569	7137 & 7138	uncharacterized oxidoreductase
ORF03570	7139 & 7140	oxidoreductase, aldo-keto reductase family [1.1.1.274]
ORF03571	7141 & 7142	conserved hypothetical protein
ORF03572	7143 & 7144	major outer membrane lipoprotein
ORF03573	7145 & 7146	radical SAM domain protein protein
ORF03574	7147 & 7148	regulator for uxu operon
ORF03575	7149 & 7150	Hypothetical oxidoreductase ydfI
ORF03576	7151 & 7152	2,3-butanediol dehydrogenase, putative [1.1.1.14]
ORF03577	7153 & 7154	Ureidoglycolate dehydrogenase [1.1.1.-]
ORF03578	7155 & 7156	TRAP-type C4-dicarboxylate transport system, periplasmic component (AP001509)
ORF03579	7157 & 7158	unnamed protein product
ORF03580	7159 & 7160	TRAP dicarboxylate transporter, DctM subunit
ORF03581	7161 & 7162	suppressor of ftsI
ORF03582	7163 & 7164	1-acyl-sn-glycerol-3-phosphate acyltransferase (LPAAT) [2.3.1.51]
ORF03583	7165 & 7166	DNA topoisomerase IV, A subunit (parC) [5.99.1.-]
ORF03584	7167 & 7168	ABC superfamily (periplasm), oligopeptide transport protein with
ORF03585	7169 & 7170	transcriptional regulator, AraC family
ORF03586	7171 & 7172	conserved hypothetical protein TIGR00156
ORF03587	7173 & 7174	Transcriptional Regulatory protein qseB
ORF03588	7175 & 7176	Sensor protein qseC [2.7.3.-]
ORF03589	7177 & 7178	unnamed protein product; Similar to Hcp protein
ORF03590	7179 & 7180	NAD(P)H quinone oxidoreductase, putative
ORF03591	7181 & 7182	Protein ygiN
ORF03592	7183 & 7184	SIS domain protein
ORF03593	7185 & 7186	Putative iron compound-binding protein of ABC transporter
ORF03594	7187 & 7188	iron compound ABC transporter, permease protein (III)
ORF03595	7189 & 7190	ferric exochelin uptake (fxuC)
ORF03596	7191 & 7192	ferric exochelin uptake (fxuB)
ORF03597	7193 & 7194	Putative iron compound receptor
ORF03598	7195 & 7196	DNA topoisomerase IV, B subunit (parE) [5.99.1.-]
ORF03599	7197 & 7198	Predicted esterase
ORF03600	7199 & 7200	Icc protein
ORF03601	7201 & 7202	Protein of unknown function (DUF1249) superfamily
ORF03602	7203 & 7204	conserved hypothetical protein TIGR00052
ORF03603	7205 & 7206	outer membrane channel specific tolerance to colicin
ORF03604	7207 & 7208	conserved hypothetical protein
ORF03605	7209 & 7210	glutathionylspermidine synthase (O386)
ORF03606	7211 & 7212	arylsulfate sulfotransferase
ORF03607	7213 & 7214	Thiol:disulfide interchange protein dsbA-like precursor [5.3.4.1]
ORF03608	7215 & 7216	disulfide bond formation protein B (dsbB) [1.8.4.-]
ORF03609	7217 & 7218	Catalytic LigB subunit of aromatic ring-opening dioxygenase superfamily
ORF03610	7219 & 7220	hypothetical protein
ORF03611	7221 & 7222	Zinc transporter zupT
ORF03612	7223 & 7224	conserved hypothetical protein
ORF03613	7225 & 7226	fimbrial protein

ORF03614	7227 & 7228	outer membrane fimbrial usher porin
ORF03615	7229 & 7230	OUTER MEMBRANE USHER PROTEIN PMFC PRECURSOR.
ORF03616	7231 & 7232	Hypothetical fimbrial chaperone yqiH precursor
ORF03617	7233 & 7234	ybgO protein
ORF03618	7235 & 7236	3,4-dihydroxy-2-butanone 4-phosphate synthase (ribB)
ORF03619	7237 & 7238	Protein of unknown function (DUF526) family
ORF03620	7239 & 7240	glycogen biosynthesis, rpoS dependent-related protein
ORF03621	7241 & 7242	YgiJ
ORF03622	7243 & 7244	Uncharacterized BCR, putative
ORF03623	7245 & 7246	ADP-heptose synthase [2.7.-.-]
ORF03624	7247 & 7248	Glutamate-ammonia-ligase adenylyltransferase
ORF03625	7249 & 7250	Adenylate cyclase, putative
ORF03626	7251 & 7252	conserved hypothetical protein
ORF03627	7253 & 7254	tRNA nucleotidyl transferase
ORF03628	7255 & 7256	undecaprenol kinase, putative [2.7.1.66]
ORF03629	7257 & 7258	dihydroneopterin aldolase (folB) [4.1.2.25]
ORF03630	7259 & 7260	conserved hypothetical protein TIGR00023
ORF03631	7261 & 7262	LysR family regulatory protein
ORF03632	7263 & 7264	hypothetical protein
ORF03633	7265 & 7266	fumarase (fumarase) [4.2.1.32]
ORF03634	7267 & 7268	fumarate hydratase, class I, putative [4.2.1.32]
ORF03635	7269 & 7270	DASS family, citrate:succinate transport (antiport)
ORF03636	7271 & 7272	O-sialoglycoprotein endopeptidase (gcp) [3.4.24.57]
ORF03637	7273 & 7274	30S ribosomal protein S21 -related protein
ORF03638	7275 & 7276	DNA primase [2.7.7.-]
ORF03639	7277 & 7278	sigma D factor of RNA polymerase
ORF03640	7279 & 7280	sigma D factor of RNA polymerase
ORF03641	7281 & 7282	G-U mismatch-specific DNA glycosylase (Mismatch-specificuracil DNA-glycosylase) (UDG) [3.2.2.-]
ORF03642	7283 & 7284	iron-chelator utilization protein
ORF03643	7285 & 7286	transcriptional regulator, PadR family
ORF03644	7287 & 7288	Aerotaxis receptor
ORF03645	7289 & 7290	ornithine aminotransferase (rocD) [2.6.1.13]
ORF03646	7291 & 7292	tRNA-binding protein ygjH (mets) [6.1.1.10]
ORF03647	7293 & 7294	galactose operon repressor galR
ORF03648	7295 & 7296	Evolved beta-galactosidase alpha-subunit
ORF03649	7297 & 7298	EGB enzyme beta subunit [3.2.1.23]
ORF03650	7299 & 7300	probable oxidoreductase ygjI
ORF03651	7301 & 7302	conserved hypothetical protein
ORF03652	7303 & 7304	conserved hypothetical protein
ORF03653	7305 & 7306	2,4-dienoyl-coA reductase [1.-.-.-]
ORF03654	7307 & 7308	2.1.1.52 [2.1.1.52]
ORF03655	7309 & 7310	conserved hypothetical protein
ORF03656	7311 & 7312	sanA protein
ORF03657	7313 & 7314	oxidoreductase [1.-.-.-]
ORF03658	7315 & 7316	Alx protein
ORF03659	7317 & 7318	Sodium:dicarboxylate symporter family superfamily
ORF03660	7319 & 7320	conserved hypothetical protein
ORF03661	7321 & 7322	Altronate hydrolase [4.2.1.7]
ORF03662	7323 & 7324	Glucuronate isomerase (uxaC) [5.3.1.12]
ORF03663	7325 & 7326	major facilitator family transporter, putative
ORF03664	7327 & 7328	Exu regulon transcriptional regulator

ORF03665	7329 & 7330	unnamed protein product; Similar to DedA-family integral membrane protein YghB of Escherichia coli
ORF03666	7331 & 7332	conserved hypothetical protein
ORF03667	7333 & 7334	Protein yqjC precursor [3.4.24.13]
ORF03668	7335 & 7336	Bacterial protein of unknown function (DUF883) superfamily
ORF03669	7337 & 7338	conserved hypothetical protein
ORF03670	7339 & 7340	conserved hypothetical protein
ORF03671	7341 & 7342	predicted membrane protein
ORF03672	7343 & 7344	Glutathione S-transferase C terminus (O328)
ORF03673	7345 & 7346	Protein of unknown function (DUF805) superfamily
ORF03674	7347 & 7348	lysR-family transcription regulatory protein YPO3545
ORF03675	7349 & 7350	Uncharacterized BCR, YhhW family COG1741 family
ORF03676	7351 & 7352	conserved hypothetical protein
ORF03677	7353 & 7354	Protein of unknown function (DUF1063) superfamily
ORF03678	7355 & 7356	putative transport system permease protein
ORF03679	7357 & 7358	L-serine ammonia-lyase (sdaA) [4.3.1.17]
ORF03680	7359 & 7360	endoribonuclease L-PSP, putative
ORF03681	7361 & 7362	formate acetyltransferase (pflB) [2.3.1.54]
ORF03682	7363 & 7364	acetate kinase (ackA) [2.7.2.1]
ORF03683	7365 & 7366	Threonine-serine transporter
ORF03684	7367 & 7368	Threonine dehydratase catabolic (Threonine deaminase) (tdcB) [4.3.1.19]
ORF03685	7369 & 7370	transcriptional regulator, LysR family, putative [4.2.1.16]
ORF03686	7371 & 7372	Glycerate kinase 2
ORF03687	7373 & 7374	2-hydroxy-3-oxopropionate reductase [1.1.1.60]
ORF03688	7375 & 7376	2-dehydro-3-deoxyglucarate aldolase (ptpA) [4.1.2.20]
ORF03689	7377 & 7378	MFS transporter, phthalate permease family
ORF03690	7379 & 7380	D-galactarate dehydratase (GalcD) [4.2.1.42]
ORF03691	7381 & 7382	DeoR-family regulatory protein (srl)
ORF03692	7383 & 7384	PUTATIVE TAGATOSE 6-PHOSPHATE KINASE PROTEIN
ORF03693	7385 & 7386	N-acetylgalactosamine-specific PTS system enzyme IIB component (EIIB-AGA) [2.7.1.69]
ORF03694	7387 & 7388	N-acetylgalactosameine-specific IIC component 2
ORF03695	7389 & 7390	PTS system, N-acetylgalactosamine-specific IID component
ORF03696	7391 & 7392	AgaF [2.7.1.69]
ORF03697	7393 & 7394	N-acetylglucosamine-6-phosphate deacetylase (nagA) [3.5.1.25]
ORF03698	7395 & 7396	sugar isomerase domain protein AgaS [5.-.-.-]
ORF03699	7397 & 7398	class II aldolase, tagatose bisphosphate family [4.1.2.-]
ORF03700	7399 & 7400	PTS system, N-acetylgalactosamine-specific IIB component 1 (EIIB-Aga)(N-acetylgalactosamine-permease IIB component 1) (Phosphotransferaseenzyme II, B component 1) (EIIB-AGA) [2.7.1.69]
ORF03701	7401 & 7402	PTS system, N-acetylgalactosamine-specific IIC component 1 (EIIC-Aga)(N-acetylgalactosamine-permease IIC component 1)
ORF03702	7403 & 7404	PTS system, N-acetylgalactosamine-specific IID component (EIID-AGA)
ORF03703	7405 & 7406	glucosamine-6-phosphate isomerase, putative [5.3.1.-]
ORF03704	7407 & 7408	conserved hypothetical protein TIGR00096
ORF03705	7409 & 7410	LppC
ORF03706	7411 & 7412	conserved hypothetical protein TIGR00252
ORF03707	7413 & 7414	phosphoheptose isomerase (gmhA)
ORF03708	7415 & 7416	Putative phospholipid-binding domain family
ORF03709	7417 & 7418	Predicted permease superfamily
ORF03710	7419 & 7420	conserved hypothetical protein
ORF03711	7421 & 7422	unnamed protein product

ORF03712	7423 & 7424	protease I
ORF03713	7425 & 7426	ACETYLTRANSFERASE [2.3.1.-]
ORF03714	7427 & 7428	predicted endonuclease
ORF03715	7429 & 7430	SCP-2 sterol transfer family family
ORF03716	7431 & 7432	collagenase
ORF03717	7433 & 7434	peptidase, U32 family family [3.4.-.-]
ORF03718	7435 & 7436	flavin dependant oxidoreductase
ORF03719	7437 & 7438	Tryptophan-specific transport protein
ORF03720	7439 & 7440	ATP-dependent RNA helicase DeaD
ORF03721	7441 & 7442	Lipoprotein nlpI precursor
ORF03722	7443 & 7444	Polyribonucleotide nucleotidyltransferase (CAP87K)
ORF03723	7445 & 7446	ribosomal protein S15 (rpsO)
ORF03724	7447 & 7448	tRNA pseudouridine synthase B [4.2.1.70]
ORF03725	7449 & 7450	ribosome-binding factor A (rbfA)
ORF03726	7451 & 7452	Translation initiation factor IF-2
ORF03727	7453 & 7454	Transcription elongation protein nusA (N utilization substance proteinA) (L factor) (nusA)
ORF03728	7455 & 7456	YhbC-like protein
ORF03729	7457 & 7458	argininosuccinate synthase (argG) [6.3.4.5]
ORF03730	7459 & 7460	Outer-membrane protein yhbX precursor
ORF03731	7461 & 7462	Protein-export membrane protein secG
ORF03732	7463 & 7464	phosphoglucosamine mutase (glmM) [5.4.2.-]
ORF03733	7465 & 7466	dihydropteroate synthase (folP) [2.5.1.15]
ORF03734	7467 & 7468	ATP-binding protein [3.4.24.-]
ORF03735	7469 & 7470	ribosomal RNA large subunit methyltransferase J (rrmJ) [2.1.1.-]
ORF03736	7471 & 7472	conserved hypothetical protein TIGR00253
ORF03737	7473 & 7474	Transcription elongation factor greA (Transcript cleavage factorgreA) (greA)
ORF03738	7475 & 7476	D-alanyl-D-alanine carboxypeptidase-D-alanyl-D-alanine-endopeptidase (dacB) [3.4.16.4]
ORF03739	7477 & 7478	Obg protein (Obg)
ORF03740	7479 & 7480	Obg protein (F390)
ORF03741	7481 & 7482	RhaT protein
ORF03742	7483 & 7484	RhaT protein
ORF03743	7485 & 7486	ribosomal protein L27 (rpmA)
ORF03744	7487 & 7488	50S ribosomal protein L21
ORF03745	7489 & 7490	conserved hypothetical protein
ORF03746	7491 & 7492	RhaT protein
ORF03747	7493 & 7494	ribosomal protein L27 (rpmA)
ORF03748	7495 & 7496	50S ribosomal protein L21
ORF03749	7497 & 7498	ribosomal protein L21 (rplU)
ORF03750	7499 & 7500	conserved hypothetical protein
ORF03751	7501 & 7502	Octaprenyl-diphosphate synthase (Octaprenyl pyrophosphatesynthetase) (OPP synthetase) [2.5.1.-]
ORF03752	7503 & 7504	Sugar fermentation stimulation protein B (Ner-like protein)
ORF03753	7505 & 7506	UDP-N-acetylglucosamine 1-carboxyvinyltransferase (murA) [2.5.1.7]
ORF03754	7507 & 7508	BolA-like protein
ORF03755	7509 & 7510	conserved hypothetical protein
ORF03756	7511 & 7512	Protein yrbC precursor (Ttg2D)
ORF03757	7513 & 7514	conserved hypothetical protein
ORF03758	7515 & 7516	VpsC
ORF03759	7517 & 7518	unnamed protein product; Highly similar to ABC transporter, permease protein YrbE of Escherichia coli

ORF03760	7519 & 7520	ABC transporter, ATP-binding protein (atp_bind)
ORF03761	7521 & 7522	K+-dependent Na+-Ca+ exchanger related-protein
ORF03762	7523 & 7524	hypothetical protein
ORF03763	7525 & 7526	conserved hypothetical protein
ORF03764	7527 & 7528	putative isomerase
ORF03765	7529 & 7530	3-deoxy-D-manno-octulosonate 8-phosphate phosphatase(KDO 8-P phosphatase) [3.1.3.45]
ORF03766	7531 & 7532	unnamed protein product; Similar to YrbK precursor protein of Escherichia coli
ORF03767	7533 & 7534	OstA-like protein family
ORF03768	7535 & 7536	ABC transporter, ATP-binding component
ORF03769	7537 & 7538	RNA polymerase sigma-54 factor (rpoN)
ORF03770	7539 & 7540	ribosomal subunit interface protein (yfiA)
ORF03771	7541 & 7542	PTS IIA-like nitrogen-regulatory protein PtsN (ptsN)
ORF03772	7543 & 7544	unnamed protein product; ORF193 peptide fragment (AA 1-192) (1524 is 2nd base in codon)
ORF03773	7545 & 7546	phosphocarrier protein (NPr)
ORF03774	7547 & 7548	conserved hypothetical protein
ORF03775	7549 & 7550	monofunctional biosynthetic peptidoglycan transglycosylase (mtgA) [2.4.2.-]
ORF03776	7551 & 7552	sigma cross-reacting protein 27A (SCRP-27A)
ORF03777	7553 & 7554	Aerobic respiration control sensor protein arcB [2.7.3.-]
ORF03778	7555 & 7556	radical SAM protein, TIGR01212 family
ORF03779	7557 & 7558	hypothetical protein
ORF03780	7559 & 7560	Glutamate synthase [NADPH] large chain precursor [1.4.1.13]
ORF03781	7561 & 7562	glutamate synthase (NADPH) small chain (NADPH) [1.4.1.13]
ORF03782	7563 & 7564	conserved hypothetical protein subfamily
ORF03783	7565 & 7566	ROK family protein domain protein, putative
ORF03784	7567 & 7568	N-acetylmannosamine-6-phosphate 2-epimerase - N-acetylmannosamine kinase
ORF03785	7569 & 7570	cis,cis-muconate transport protein MucK, putative
ORF03786	7571 & 7572	N-acetylneuraminate lyase (nanA) [4.1.3.3]
ORF03787	7573 & 7574	transcriptional regulator, GntR family, putative
ORF03788	7575 & 7576	stringent starvation protein B (sspB)
ORF03789	7577 & 7578	Stringent starvation protein A (Ssp)
ORF03790	7579 & 7580	ribosomal protein S9 (rpsI)
ORF03791	7581 & 7582	ribosomal protein L13 (rplM)
ORF03792	7583 & 7584	Predicted ATPase
ORF03793	7585 & 7586	Protein of unknown function (DUF1043) superfamily
ORF03794	7587 & 7588	Protease degQ precursor
ORF03795	7589 & 7590	periplasmic serine protease DegS (degS) [3.4.21.-]
ORF03796	7591 & 7592	malate dehydrogenase, NAD-dependent (mdh) [1.1.1.37]
ORF03797	7593 & 7594	arginine repressor (argR)
ORF03798	7595 & 7596	Protein of unknown function (DUF1471) superfamily
ORF03799	7597 & 7598	unnamed protein product; Similar to ribonuclease inhibitor (barstar)
ORF03800	7599 & 7600	Fusaric acid resistance protein conserved region family
ORF03801	7601 & 7602	fusaric acid resistance protein
ORF03802	7603 & 7604	conserved hypothetical protein
ORF03803	7605 & 7606	conserved hypothetical protein
ORF03804	7607 & 7608	Transcriptional regulator
ORF03805	7609 & 7610	TldD protein (CSRA)
ORF03806	7611 & 7612	conserved hypothetical protein TIGR02099
ORF03807	7613 & 7614	bundles of cytoplasmic filaments
ORF03808	7615 & 7616	maf protein (maf)
ORF03809	7617 & 7618	rod shape-determining protein MreD (mreD)

ORF03810	7619 & 7620	Rod shape-determining protein mreC (mreC)
ORF03811	7621 & 7622	Rod shape-determining protein mreC (mreC)
ORF03812	7623 & 7624	regulator of ftsI
ORF03813	7625 & 7626	EAL domain protein
ORF03814	7627 & 7628	Protein yhdH
ORF03815	7629 & 7630	acetyl-CoA carboxylase, biotin carboxyl carrier protein (accB)
ORF03816	7631 & 7632	acetyl-CoA carboxylase, biotin carboxylase (accC) [6.4.1.2]
ORF03817	7633 & 7634	conserved hypothetical protein
ORF03818	7635 & 7636	conserved hypothetical protein
ORF03819	7637 & 7638	fructokinase (AB010074) [2.7.1.-]
ORF03820	7639 & 7640	ribose ABC transporter, permease protein (permease)
ORF03821	7641 & 7642	Ribose transport ATP-binding protein rbsA (aldose)
ORF03822	7643 & 7644	periplasmic ribose-binding protein
ORF03823	7645 & 7646	class II aldolase, tagatose bisphosphate family [4.1.2.-]
ORF03824	7647 & 7648	conserved hypothetical protein
ORF03825	7649 & 7650	aga operon transcriptional repressor (DeoR family)
ORF03826	7651 & 7652	fructokinase (AB010074) [2.7.1.-]
ORF03827	7653 & 7654	Protein of unknown function (DUF997) superfamily
ORF03828	7655 & 7656	sodium-pantothenate symporter (panF)
ORF03829	7657 & 7658	ribosomal protein L11 methyltransferase (prmA) [2.1.1.-]
ORF03830	7659 & 7660	tRNA-dihydrouridine synthase B [1.-.-.-]
ORF03831	7661 & 7662	DNA-binding protein fis (Factor-for-inversion stimulation protein)(HIN recombinational enhancer binding protein) (fis)
ORF03832	7663 & 7664	ADENINE-SPECIFIC METHYLTRANSFERASE
ORF03833	7665 & 7666	conserved hypothetical protein
ORF03834	7667 & 7668	Potential acrEF-envCD operon repressor (acrEF)
ORF03835	7669 & 7670	Acriflavine resistance protein E precursor
ORF03836	7671 & 7672	Acriflavine resistance protein F
ORF03837	7673 & 7674	lipoprotein, putative
ORF03838	7675 & 7676	amino acid ABC transporter, periplasmic amino acid-binding protein
ORF03839	7677 & 7678	L-amino acid ABC transporter permease protein
ORF03840	7679 & 7680	L-amino acid ABC transporter permease protein
ORF03841	7681 & 7682	L-amino acid ABC transporter ATP-binding protein
ORF03842	7683 & 7684	glutamate decarboxylase [4.1.1.15]
ORF03843	7685 & 7686	glutamate decarboxylase [4.1.1.15]
ORF03844	7687 & 7688	unnamed protein product
ORF03845	7689 & 7690	Protein yrdA
ORF03846	7691 & 7692	shikimate 5-dehydrogenase (aroE) [1.1.1.25]
ORF03847	7693 & 7694	Protein yrdC
ORF03848	7695 & 7696	Protein smg
ORF03849	7697 & 7698	Predicted Rossmann-fold nucleotide-binding protein involved in DNA
ORF03850	7699 & 7700	peptide deformylase (def) [3.5.1.88]
ORF03851	7701 & 7702	methionyl-tRNA formyltransferase (fmt) [2.1.2.9]
ORF03852	7703 & 7704	sun protein (sun) [2.1.1.-]
ORF03853	7705 & 7706	Trk system potassium uptake protein trkA (K(+)-uptake protein trkA) (trkA)
ORF03854	7707 & 7708	large conductance mechanosensitive channel protein (mscL)
ORF03855	7709 & 7710	Uncharacterized protein conserved in bacteria
ORF03856	7711 & 7712	Zn(II)-responsive transcriptional regulator (zntR)
ORF03857	7713 & 7714	conserved hypothetical protein
ORF03858	7715 & 7716	ribosomal protein L17 (rplQ)
ORF03859	7717 & 7718	DNA-directed RNA polymerase, alpha subunit (rpoA) [2.7.7.6]
ORF03860	7719 & 7720	ribosomal protein S4 (rpsD)

ORF03861	7721 & 7722	ribosomal protein S11 (rpsK)
ORF03862	7723 & 7724	ribosomal protein S13p-S18e (rpsM)
ORF03863	7725 & 7726	ribosomal protein L36 (rpmJ)
ORF03864	7727 & 7728	preprotein translocase, SecY subunit
ORF03865	7729 & 7730	Preprotein translocase secY subunit (secY)
ORF03866	7731 & 7732	ribosomal protein L15 (rplO)
ORF03867	7733 & 7734	ribosomal protein L30 (rpmD)
ORF03868	7735 & 7736	ribosomal protein S5 (rpsE)
ORF03869	7737 & 7738	ribosomal protein L18 (rplR)
ORF03870	7739 & 7740	50S ribosomal subunit protein L6 (rp1F)
ORF03871	7741 & 7742	conserved hypothetical protein
ORF03872	7743 & 7744	ribosomal protein S8 (rpsH)
ORF03873	7745 & 7746	ribosomal protein S14p-S29e (rpsN)
ORF03874	7747 & 7748	50S ribosomal subunit protein L5 (rpL5)
ORF03875	7749 & 7750	ribosomal protein L24 (rplX)
ORF03876	7751 & 7752	ribosomal protein L14 (rplN)
ORF03877	7753 & 7754	ribosomal protein S17 (rpsQ)
ORF03878	7755 & 7756	ribosomal protein L29 (rpmC)
ORF03879	7757 & 7758	ribosomal protein L16 (rplP)
ORF03880	7759 & 7760	ribosomal protein S3 (rpsC)
ORF03881	7761 & 7762	ribosomal protein L22 (rplV)
ORF03882	7763 & 7764	ribosomal protein S19 (rpsS)
ORF03883	7765 & 7766	ribosomal protein L2 (rplB)
ORF03884	7767 & 7768	ribosomal protein L23 (rplW)
ORF03885	7769 & 7770	ribosomal protein L4-L1 family (rplD)
ORF03886	7771 & 7772	ribosomal protein L3 (rplC)
ORF03887	7773 & 7774	ribosomal protein S10 (rpsJ)
ORF03888	7775 & 7776	PioO protein (PinO protein)
ORF03889	7777 & 7778	Probable general secretion pathway protein A (GSP)
ORF03890	7779 & 7780	general secretion pathway protein C (gspC)
ORF03891	7781 & 7782	General secretion pathway protein D precursor (Pullulanase secretionenvelope pulD) (GSP)
ORF03892	7783 & 7784	General secretion pathway protein E (Type II traffic warden ATPase)(Cholera toxin secretion protein epsE) (GSP)
ORF03893	7785 & 7786	general secretion pathway protein F (gspF)
ORF03894	7787 & 7788	general secretion pathway protein G (gspG)
ORF03895	7789 & 7790	General secretion pathway protein H precursor (Pullulanase secretionprotein pulH) (GSP)
ORF03896	7791 & 7792	outer membrane secretion protein V (GSP)
ORF03897	7793 & 7794	general secretion pathway protein J (gspJ)
ORF03898	7795 & 7796	General secretion pathway protein K (gspK)
ORF03899	7797 & 7798	general secretion pathway protein L (gspL)
ORF03900	7799 & 7800	Putative general secretion pathway protein M (GSP)
ORF03901	7801 & 7802	Type 4 prepilin-like proteins leader peptide processing enzyme (GSP) [3.4.23.43]
ORF03902	7803 & 7804	bacterioferritin (bfr)
ORF03903	7805 & 7806	Bacterioferritin-associated ferredoxin-related protein
ORF03904	7807 & 7808	chitinase [3.2.1.14]
ORF03905	7809 & 7810	translation elongation factor Tu (tuf)
ORF03906	7811 & 7812	translation elongation factor G (fusA)
ORF03907	7813 & 7814	ribosomal protein S7 (rpsG)
ORF03908	7815 & 7816	ribosomal protein S12 (rpsL)
ORF03909	7817 & 7818	DsrH protein

ORF03910	7819 & 7820	Uncharacterized protein involved in the oxidation of
ORF03911	7821 & 7822	Uncharacterized conserved protein involved in intracellular sulfur
ORF03912	7823 & 7824	conserved hypothetical protein
ORF03913	7825 & 7826	FKBP-type peptidyl-prolyl cis-trans isomerase fkpA precursor(EC 5.2.1.8) (PPIase) (Rotamase) (rotamase) [5.2.1.8]
ORF03914	7827 & 7828	SlyX protein (slyX)
ORF03915	7829 & 7830	FKBP-type peptidyl-prolyl cis-trans isomerase slyD(PPIase) (Rotamase) (Histidine-rich protein) (WHP) (rotamase) [5.2.1.8]
ORF03916	7831 & 7832	conserved hypothetical protein
ORF03917	7833 & 7834	Glutathione-regulated potassium-efflux system protein kefB (K(+)-H(+)antiporter) (NEM-activatable K(+)-H(+) antiporter)
ORF03918	7835 & 7836	Glutathione-regulated potassium-efflux system ancillary protein kefG [1.6.99.2]
ORF03919	7837 & 7838	ABC transporter ATP-binding protein
ORF03920	7839 & 7840	Predicted hydrolase of the alpha-beta-hydrolase fold
ORF03921	7841 & 7842	Hypothetical UPF0270 protein yheU-related protein
ORF03922	7843 & 7844	phosphoribulokinase [2.7.1.19]
ORF03923	7845 & 7846	no known function
ORF03924	7847 & 7848	Catabolite gene activator (cAMP receptor protein) (cAMP-regulatoryprotein) (crp)
ORF03925	7849 & 7850	integral membrane protein, YccS-YhfK family subfamily
ORF03926	7851 & 7852	Acetylornithine aminotransferase (argD) [2.6.1.11]
ORF03927	7853 & 7854	Para-aminobenzoate synthase glutamine amidotransferase component II [6.3.5.8]
ORF03928	7855 & 7856	fic, putative
ORF03929	7857 & 7858	Peptidyl-prolyl cis-trans isomerase A precursor (PPIaseA) (Rotamase A) (Cyclophilin A) (utu) [5.2.1.8]
ORF03930	7859 & 7860	hypothetical protein
ORF03931	7861 & 7862	TsgA protein
ORF03932	7863 & 7864	nitrite reductase [NAD(P)H], large subunit (nirB) [1.7.1.4]
ORF03933	7865 & 7866	nitrite reductase [NAD(P)H], small subunit (nirD) [1.7.1.4]
ORF03934	7867 & 7868	Potential nitrite transporter (formate)
ORF03935	7869 & 7870	Siroheme synthase
ORF03936	7871 & 7872	lipoprotein, putative
ORF03937	7873 & 7874	unnamed protein product
ORF03938	7875 & 7876	membrane protein, putative
ORF03939	7877 & 7878	conserved hypothetical protein
ORF03940	7879 & 7880	parathion hydrolase, putative
ORF03941	7881 & 7882	phosphopentomutase
ORF03942	7883 & 7884	Alanine racemase, N-terminal domain family
ORF03943	7885 & 7886	unnamed protein product
ORF03944	7887 & 7888	conserved hypothetical protein
ORF03945	7889 & 7890	tryptophanyl-tRNA synthetase (trpS) [6.1.1.2]
ORF03946	7891 & 7892	phosphoglycolate phosphatase, bacterial (gph) [3.1.3.18]
ORF03947	7893 & 7894	hypothetical protein
ORF03948	7895 & 7896	Phosphoglycolate phosphatase (PGP) [3.1.3.18]
ORF03949	7897 & 7898	ribulose-phosphate 3-epimerase (rpe) [5.1.3.1]
ORF03950	7899 & 7900	DNA adenine methylase (dam) [2.1.1.72]
ORF03951	7901 & 7902	DamX protein (1989)
ORF03952	7903 & 7904	3-dehydroquinate synthase (aroB) [4.2.3.4]
ORF03953	7905 & 7906	shikimate kinase I
ORF03954	7907 & 7908	Protein transport protein hofQ precursor (Tfp)
ORF03955	7909 & 7910	conserved hypothetical protein
ORF03956	7911 & 7912	conserved hypothetical protein

ORF03957	7913 & 7914	Fimbrial assembly protein (PilN) superfamily
ORF03958	7915 & 7916	conserved hypothetical protein
ORF03959	7917 & 7918	Penicillin-binding protein 1A (PBP1a) [2.4.2.-]
ORF03960	7919 & 7920	ADP compounds hydrolase nudE [3.6.1.-]
ORF03961	7921 & 7922	Intracellular growth attenuator protein igaA
ORF03962	7923 & 7924	HAD-superfamily hydrolase, subfamily IA, variant 3 protein family
ORF03963	7925 & 7926	Heat shock protein 15 (HSP15) (HSP15)
ORF03964	7927 & 7928	33 kDa chaperonin (Heat shock protein 33) (HSP33) (HSP33)
ORF03965	7929 & 7930	membrane protein, putative
ORF03966	7931 & 7932	phosphoenolpyruvate carboxykinase (ATP) (pckA) [4.1.1.49]
ORF03967	7933 & 7934	Osmolarity sensor protein envZ [2.7.3.-]
ORF03968	7935 & 7936	response regulator (sensor, EnvZ) affecting transcription of ompC and ompF: outer membrane protein synthesis
ORF03969	7937 & 7938	transcription elongation factor GreB (greB)
ORF03970	7939 & 7940	Protein yhgF
ORF03971	7941 & 7942	ferrous iron transport protein B
ORF03972	7943 & 7944	ferrous iron transport protein B (feoB)
ORF03973	7945 & 7946	conserved hypothetical protein
ORF03974	7947 & 7948	transposase
ORF03975	7949 & 7950	hypothetical protein
ORF03976	7951 & 7952	bioH protein (bioH)
ORF03977	7953 & 7954	hypothetical protein
ORF03978	7955 & 7956	predicted amidophosphoribosyltransferase
ORF03979	7957 & 7958	Protein yhgI
ORF03980	7959 & 7960	High-affinity gluconate transporter (Gluconate permease) (Gnt-Isystem)
ORF03981	7961 & 7962	4-alpha-glucanotransferase (malQ) [2.4.1.25]
ORF03982	7963 & 7964	Maltodextrin phosphorylase [2.4.1.1]
ORF03983	7965 & 7966	transcriptional regulator, LuxR family, putative
ORF03984	7967 & 7968	RNA 3'-terminal phosphate cyclase (rtcA) [6.5.1.4]
ORF03985	7969 & 7970	Protein rtcB
ORF03986	7971 & 7972	Glycerol-3-phosphate regulon repressor
ORF03987	7973 & 7974	Transcriptional Regulatory protein rtcR
ORF03988	7975 & 7976	Rhomboid family protein, putative
ORF03989	7977 & 7978	unnamed protein product; glpE polypeptide (AA 1-131)
ORF03990	7979 & 7980	Aerobic glycerol-3-phosphate dehydrogenase (aerobic)
ORF03991	7981 & 7982	conserved hypothetical protein
ORF03992	7983 & 7984	conserved hypothetical protein
ORF03993	7985 & 7986	conserved hypothetical protein
ORF03994	7987 & 7988	mannose binding protein FimH precursor
ORF03995	7989 & 7990	fimbrial chaperone
ORF03996	7991 & 7992	Putative minor fimbrial subunit precursor
ORF03997	7993 & 7994	Putative minor fimbrial subunit precursor
ORF03998	7995 & 7996	F1C fimbrial usher
ORF03999	7997 & 7998	Chaperone protein fimC precursor
ORF04000	7999 & 8000	Long polar fimbria protein A precursor (pilin)
ORF04001	8001 & 8002	Glycogen phosphorylase [2.4.1.1]
ORF04002	8003 & 8004	Glycogen synthase (Starch [bacterial glycogen]synthase) [2.4.1.21]
ORF04003	8005 & 8006	glucose-1-phosphate adenylyltransferase (glgC) [2.7.7.27]
ORF04004	8007 & 8008	glycogen debranching enzyme GlgX (glgX) [3.2.1.-]
ORF04005	8009 & 8010	1,4-alpha-glucan branching enzyme (glgB) [2.4.1.18]
ORF04006	8011 & 8012	aspartate-semialdehyde dehydrogenase (asd) [1.2.1.11]

ORF04007	8013 & 8014	membrane protein, putative
ORF04008	8015 & 8016	gluconate permease, putative
ORF04009	8017 & 8018	thermoresistant gluconokinase (gluconate kinase 2)
ORF04010	8019 & 8020	HTH-type transcriptional regulator gntR (Gluconate utilization systemGNT-I transcriptional repressor) (gnt)
ORF04011	8021 & 8022	Protein yhhW
ORF04012	8023 & 8024	Putative oxidoreductase yhhX [1.-.-.-]
ORF04013	8025 & 8026	conserved hypothetical protein
ORF04014	8027 & 8028	acetyltransferase, GNAT family, putative [2.3.1.-]
ORF04015	8029 & 8030	unnamed protein product; Similar to Hcp protein
ORF04016	8031 & 8032	conserved hypothetical protein
ORF04017	8033 & 8034	gamma-glutamyltransferase (ggt) [2.3.2.2]
ORF04018	8035 & 8036	glycerophosphodiester phosphodiesterase [3.1.4.46]
ORF04019	8037 & 8038	CG9973-PA
ORF04020	8039 & 8040	SN-glycerol-3-phosphate transport ATP-binding protein ugpC
ORF04021	8041 & 8042	SN-glycerol-3-phosphate transport system permease protein ugpE (membrane)
ORF04022	8043 & 8044	glycerol-3-phosphate ABC transporter, permease protein (membrane)
ORF04023	8045 & 8046	Glycerol-3-phosphate-binding periplasmic protein precursor
ORF04024	8047 & 8048	ABC transporter domain protein
ORF04025	8049 & 8050	High-affinity branched-chain amino acid transport ATP-binding proteinlivG (LIV-I protein G) (AJ272047)
ORF04026	8051 & 8052	High-affinity branched-chain amino acid transport system permeaseprotein livM (LIV-I protein M)
ORF04027	8053 & 8054	High-affinity branched-chain amino acid transport system permease protein livH
ORF04028	8055 & 8056	Leucine-specific binding protein precursor
ORF04029	8057 & 8058	acetyltransferase, GNAT family family
ORF04030	8059 & 8060	Leu-Ile-Val-binding protein precursor
ORF04031	8061 & 8062	PTS system, mannose-specific enzyme II, AB component (EIII-MAN) [2.7.1.69]
ORF04032	8063 & 8064	PTS system, mannose-specific IIAB components, putative [2.7.1.69]
ORF04033	8065 & 8066	PTS system, IIC component (PTS)
ORF04034	8067 & 8068	mannose-specific PTS enzyme IID
ORF04035	8069 & 8070	D-3-phosphoglycerate dehydrogenase (serA) [1.1.1.95]
ORF04036	8071 & 8072	dihydrodipicolinate synthase (dapA) [4.2.1.52]
ORF04037	8073 & 8074	alternative sigma factor RpoH (rpoH)
ORF04038	8075 & 8076	putative protein insertion permease FtsX (ftsX)
ORF04039	8077 & 8078	Cell division ATP-binding protein ftsE
ORF04040	8079 & 8080	Cell division protein ftsY
ORF04041	8081 & 8082	methyltransferase, putative
ORF04042	8083 & 8084	overlaps previous ORF, probably uses downstream start
ORF04043	8085 & 8086	conserved hypothetical protein
ORF04044	8087 & 8088	membrane protein, putative
ORF04045	8089 & 8090	Lead, cadmium, zinc and mercury transporting ATPase [3.6.3.3]
ORF04046	8091 & 8092	SirA protein
ORF04047	8093 & 8094	membrane protein (o221)
ORF04048	8095 & 8096	DcrB protein precursor
ORF04049	8097 & 8098	Hypothetical UPF0226 protein yhhS
ORF04050	8099 & 8100	Domain of unknown function, putative
ORF04051	8101 & 8102	4'-phosphopantetheinyl transferase acpT [2.7.8.-]
ORF04052	8103 & 8104	nickel ABC transporter, periplasmic nickel-binding protein (nikA)
ORF04053	8105 & 8106	Nickel transport system permease protein nikB (permease)
ORF04054	8107 & 8108	dipeptide ABC transporter, permease protein, putative
ORF04055	8109 & 8110	Nickel transport ATP-binding protein nikD

ORF04056	8111 & 8112	Nickel transport ATP-binding protein nikE
ORF04057	8113 & 8114	Nickel responsive regulator
ORF04058	8115 & 8116	transcriptional regulator, GntR family, putative
ORF04059	8117 & 8118	PTS system IIA component, probable , putative
ORF04060	8119 & 8120	PTS system, galactitol-specific enzyme II, B component [2.7.1.69]
ORF04061	8121 & 8122	PTS system, sorbitol-specific IIC component
ORF04062	8123 & 8124	probable xylulose kinase Z4878 [2.7.1.30]
ORF04063	8125 & 8126	phosphotransferase system HPr enzyme (PTS)
ORF04064	8127 & 8128	Tagatose-bisphosphate aldolase GatY [4.1.2.-]
ORF04065	8129 & 8130	ABC-2 type transporter family
ORF04066	8131 & 8132	ribosome-associated ATPase, ATP-binding domain (N-terminal)
ORF04067	8133 & 8134	Type I antifreeze protein:HlyD family secretion protein
ORF04068	8135 & 8136	membrane protein, putative
ORF04069	8137 & 8138	conserved hypothetical protein TIGR00275
ORF04070	8139 & 8140	Low-affinity inorganic phosphate transporter 1
ORF04071	8141 & 8142	Universal stress protein B
ORF04072	8143 & 8144	universal stress protein A (UspA)
ORF04073	8145 & 8146	hypothetical protein
ORF04074	8147 & 8148	Hypothetical transporter yhiP
ORF04075	8149 & 8150	gtg start, alternate starts possible
ORF04076	8151 & 8152	Oligopeptidase A
ORF04077	8153 & 8154	Protein of unknown function (DUF519) superfamily
ORF04078	8155 & 8156	glutathione-disulfide reductase (gor) [1.8.1.7]
ORF04079	8157 & 8158	conserved hypothetical protein
ORF04080	8159 & 8160	Arsenate reductase [1.20.4.1]
ORF04081	8161 & 8162	outer membrane protein induced after carbon starvation
ORF04082	8163 & 8164	Hypothetical transcriptional regulator yhiF
ORF04083	8165 & 8166	Hemin transport protein hmuS
ORF04084	8167 & 8168	outer membrane hemin receptor ChuA
ORF04085	8169 & 8170	conserved hypothetical protein
ORF04086	8171 & 8172	Putative Periplasmic binding protein
ORF04087	8173 & 8174	HugW
ORF04088	8175 & 8176	HuvX protein (fragment)
ORF04089	8177 & 8178	conserved hypothetical protein
ORF04090	8179 & 8180	hemin ABC transporter permease protein
ORF04091	8181 & 8182	hemin transport system ATP-binding protein
ORF04092	8183 & 8184	cation transport ATPase yqgG
ORF04093	8185 & 8186	protein hdeB precursor
ORF04094	8187 & 8188	Protein hdeA precursor, putative
ORF04095	8189 & 8190	HdeD protein
ORF04096	8191 & 8192	conserved hypothetical protein
ORF04097	8193 & 8194	multidrug efflux pump SdeX
ORF04098	8195 & 8196	RND family, acridine-multidrug efflux pump
ORF04099	8197 & 8198	HTH-type transcriptional regulator appY (M5 polypeptide)
ORF04100	8199 & 8200	Transcriptional regulator gadX
ORF04101	8201 & 8202	glutamate decarboxylase [4.1.1.15]
ORF04102	8203 & 8204	cytochrome c551 peroxidase
ORF04103	8205 & 8206	Trehalase [3.2.1.28]
ORF04104	8207 & 8208	virulence regulator
ORF04105	8209 & 8210	transcriptional regulator
ORF04106	8211 & 8212	ribonuclease, putative
ORF04107	8213 & 8214	metabolite-proton symporter

ORF04108	8215 & 8216	Uncharacterized protein involved in outer membrane biogenesis
ORF04109	8217 & 8218	EAL domain, putative
ORF04110	8219 & 8220	2-dehydro-3-deoxygluconokinase
ORF04111	8221 & 8222	Protein yhjJ precursor [3.4.99.-]
ORF04112	8223 & 8224	Aerobic C4-dicarboxylate transport protein
ORF04113	8225 & 8226	Protein yhjK
ORF04114	8227 & 8228	Cellulose synthase operon protein C
ORF04115	8229 & 8230	Endoglucanase precursor
ORF04116	8231 & 8232	Cyclic di-GMP binding protein precursor
ORF04117	8233 & 8234	Cellulose synthase catalytic subunit [UDP-forming]
ORF04118	8235 & 8236	YhjQ protein family
ORF04119	8237 & 8238	conserved hypothetical protein
ORF04120	8239 & 8240	conserved hypothetical protein
ORF04121	8241 & 8242	conserved hypothetical protein
ORF04122	8243 & 8244	conserved hypothetical protein
ORF04123	8245 & 8246	conserved hypothetical protein
ORF04124	8247 & 8248	Hypothetical transport protein yhjV
ORF04125	8249 & 8250	peptide ABC transporter, ATP-binding protein (atp_bind)
ORF04126	8251 & 8252	Dipeptide transport ATP-binding protein dppD (atp_bind)
ORF04127	8253 & 8254	Dipeptide transport system permease protein dppC (membrane)
ORF04128	8255 & 8256	Dipeptide transport system permease protein dppB (permease)
ORF04129	8257 & 8258	Periplasmic dipeptide transport protein precursor (DBP)
ORF04130	8259 & 8260	conserved hypothetical protein
ORF04131	8261 & 8262	Membrane-protein yhjW
ORF04132	8263 & 8264	putative resistance protein
ORF04133	8265 & 8266	conserved hypothetical protein
ORF04134	8267 & 8268	DNA-3-methyladenine glycosylase I [3.2.2.20]
ORF04135	8269 & 8270	Biotin sulfoxide reductase
ORF04136	8271 & 8272	Hypothetical acetyltransferase yiaC (GNAT) [2.3.1.-]
ORF04137	8273 & 8274	probable outer membrane protein yiaD
ORF04138	8275 & 8276	2-ketogluconate reductase [1.1.1.215]
ORF04139	8277 & 8278	lipoprotein, putative
ORF04140	8279 & 8280	Putative HTH-type transcriptional regulator yiaG
ORF04141	8281 & 8282	cold shock-like protein
ORF04142	8283 & 8284	probable membrane permeability altering protein Z4982 -related protein
ORF04143	8285 & 8286	glycyl-tRNA synthetase, beta subunit (glyS) [6.1.1.14]
ORF04144	8287 & 8288	glycyl-tRNA synthetase, alpha subunit (glyQ) [6.1.1.14]
ORF04145	8289 & 8290	conserved hypothetical protein
ORF04146	8291 & 8292	Acyltransferase family, putative
ORF04147	8293 & 8294	yiaA-B two helix domain family
ORF04148	8295 & 8296	yiaA-B two helix domain family
ORF04149	8297 & 8298	xylulokinase (xylB) [2.7.1.17]
ORF04150	8299 & 8300	xylose isomerase (xylA) [5.3.1.5]
ORF04151	8301 & 8302	D-xylose ABC transporter, periplasmic-D xylose binding protein
ORF04152	8303 & 8304	sugar ABC transporter, ATP-binding protein (xylG)
ORF04153	8305 & 8306	sugar ABC transporter, permease protein
ORF04154	8307 & 8308	Xylose operon regulatory protein (xylR)
ORF04155	8309 & 8310	BAX protein
ORF04156	8311 & 8312	Alpha-amylase precursor [3.2.1.1]
ORF04157	8313 & 8314	Valine--pyruvate aminotransferase
ORF04158	8315 & 8316	Electron transport protein hydN
ORF04159	8317 & 8318	IclR family transcriptional repressor

ORF04160	8319 & 8320	2-keto reductase [1.1.1.-]
ORF04161	8321 & 8322	YiaL
ORF04162	8323 & 8324	YiaX1
ORF04163	8325 & 8326	TRAP transporter, DctQ-like membrane protein superfamily
ORF04164	8327 & 8328	C4-dicarboxylate transport system permease large protein (DctM)
ORF04165	8329 & 8330	DctP protein (AP001509)
ORF04166	8331 & 8332	sugar kinase, FGGY family, putative [2.7.1.53]
ORF04167	8333 & 8334	hexulose-6-phosphate synthase (humps) [4.1.2.-]
ORF04168	8335 & 8336	hexulose-6-phosphate isomerase, putative
ORF04169	8337 & 8338	L-ribulose-5-phosphate 4-epimerase (araD) [5.1.3.4]
ORF04170	8339 & 8340	aldehyde dehydrogenase family protein (AF029733)
ORF04171	8341 & 8342	Fic protein family family
ORF04172	8343 & 8344	alcohol dehydrogenase, class IV [1.1.1.1]
ORF04173	8345 & 8346	selenocysteine-specific translation elongation factor (selB)
ORF04174	8347 & 8348	L-seryl-tRNA selenium transferase (selA) [2.9.1.1]
ORF04175	8349 & 8350	Hypothetical GST-like protein yibF
ORF04176	8351 & 8352	multidrug resistance efflux pump
ORF04177	8353 & 8354	GTPase
ORF04178	8355 & 8356	PTS system, mannitol-specific enzyme IIABC components [2.7.1.69]
ORF04179	8357 & 8358	Mannitol-1-phosphate 5-dehydrogenase [1.1.1.17]
ORF04180	8359 & 8360	Mannitol operon repressor (Mannitol repressor protein)
ORF04181	8361 & 8362	conserved hypothetical protein
ORF04182	8363 & 8364	conserved hypothetical protein
ORF04183	8365 & 8366	conserved hypothetical protein
ORF04184	8367 & 8368	surface protein (partial)
ORF04185	8369 & 8370	L-lactate permease
ORF04186	8371 & 8372	transcriptional regulator
ORF04187	8373 & 8374	L-lactate dehydrogenase (lctD) [1.1.2.3]
ORF04188	8375 & 8376	RNA methyltransferase, TrmH family, group 2
ORF04189	8377 & 8378	Serine acetyltransferase (SAT) (SAT) [2.3.1.30]
ORF04190	8379 & 8380	Glycerol-3-phosphate dehydrogenase [NAD(P)+] (NAD(P)H-dependent glycerol-3-phosphate dehydrogenase) (gpsA) [1.1.1.94]
ORF04191	8381 & 8382	protein-export protein SecB (secB)
ORF04192	8383 & 8384	glutaredoxin 3 (grxC)
ORF04193	8385 & 8386	Rhodanese-like domain protein
ORF04194	8387 & 8388	2,3-bisphosphoglycerate-independent phosphoglycerate mutase (gpmI) [5.4.2.1]
ORF04195	8389 & 8390	Membrane-bound metallopeptidase
ORF04196	8391 & 8392	glycosyl transferase, group 2 family protein, putative [2.-.-.-]
ORF04197	8393 & 8394	yibQ gene product
ORF04198	8395 & 8396	L-threonine 3-dehydrogenase (tdh) [1.1.1.103]
ORF04199	8397 & 8398	2-amino-3-ketobutyrate coenzyme A ligase (kbl) [2.3.1.29]
ORF04200	8399 & 8400	ADP-L-glycero-D-manno-heptose-6-epimerase (rfaD) [5.1.3.20]
ORF04201	8401 & 8402	lipopolysaccharide heptosyltransferase II (rfaF)
ORF04202	8403 & 8404	lipopolysaccharide heptosyltransferase I (rfaC) [2.-.-.-]
ORF04203	8405 & 8406	Lipid A-core, surface polymer ligase
ORF04204	8407 & 8408	beta-1,3-glucosyltransferase [2.4.1.166]
ORF04205	8409 & 8410	UDP-galactose:(galactosyl)LPS alpha-1,2-galactosyltransferase (glucosyl) [2.4.1.58]
ORF04206	8411 & 8412	heptosyl-II-kinase
ORF04207	8413 & 8414	UDP-galactose: (glucosyl) [2.4.1.58]
ORF04208	8415 & 8416	UDP-glucose: (glucosyl) [2.4.1.44]
ORF04209	8417 & 8418	Lipopolysaccharide core biosynthesis protein rfaP

ORF04210	8419 & 8420	UDP-glucose: (heptosyl) [2.4.1.-]
ORF04211	8421 & 8422	lipopolysaccharide heptosyltransferase III, putative
ORF04212	8423 & 8424	3-deoxy-D-manno-octulosonic-acid transferase (KDOtransferase) (KDO) [2.-.-.-]
ORF04213	8425 & 8426	pantetheine-phosphate adenylyltransferase (coaD) [2.7.7.3]
ORF04214	8427 & 8428	formamidopyrimidine-DNA glycosylase (mutM) [3.2.2.23]
ORF04215	8429 & 8430	ribosomal protein L33 (rpmG)
ORF04216	8431 & 8432	RpmB protein (rpL28)
ORF04217	8433 & 8434	DNA repair protein
ORF04218	8435 & 8436	phosphopantothenoylcysteine decarboxylase-phosphopantothenate--cysteine ligase (coaBC) [4.1.1.36 6.3.2.5]
ORF04219	8437 & 8438	Deoxyuridine 5'-triphosphate nucleotidohydrolase (dut) [3.6.1.23]
ORF04220	8439 & 8440	Ttk protein
ORF04221	8441 & 8442	orotate phosphoribosyltransferase (pyrE) [2.4.2.10]
ORF04222	8443 & 8444	ribonuclease PH (rph) [2.7.7.56]
ORF04223	8445 & 8446	conserved hypothetical protein TIGR00255
ORF04224	8447 & 8448	hypothetical protein
ORF04225	8449 & 8450	DNA-damage-inducible protein D
ORF04226	8451 & 8452	predicted membrane protein
ORF04227	8453 & 8454	Hypothetical DNA ligase-like protein yicF
ORF04228	8455 & 8456	conserved hypothetical protein
ORF04229	8457 & 8458	guanylate kinase
ORF04230	8459 & 8460	DNA-directed RNA polymerase omega chain (RNAP omegasubunit) (Transcriptase omega chain) (RNA polymerase omega subunit) (rpoZ) [2.7.7.6]
ORF04231	8461 & 8462	Guanosine-3,5-bis(Diphosphate) 3-pyrophosphohydrolase (ppGpp)
ORF04232	8463 & 8464	tRNA (Guanosine-2'-O-)-methyltransferase (Gm18) [2.1.1.34]
ORF04233	8465 & 8466	ATP-dependent DNA helicase RecG (recG) [3.6.1.-]
ORF04234	8467 & 8468	sodium-glutamate symporter (gltS)
ORF04235	8469 & 8470	xanthine-uracil permease family protein
ORF04236	8471 & 8472	possible exported protein
ORF04237	8473 & 8474	Protein of unknown function (DUF1498) superfamily
ORF04238	8475 & 8476	possible NAGC-like transcriptional regulator
ORF04239	8477 & 8478	fructose-bisphosphate aldolase, class II family [4.1.2.13]
ORF04240	8479 & 8480	fructose-bisphosphate aldolase, class II family [4.1.2.-]
ORF04241	8481 & 8482	PTS system, IIbc component (PTS) [2.7.1.69]
ORF04242	8483 & 8484	PTS system, fructose-like-2 IIB component 1
ORF04243	8485 & 8486	PTS system, EIIa component (PTS) [2.7.1.69]
ORF04244	8487 & 8488	transcription antiterminator BglG family protein,, putative
ORF04245	8489 & 8490	f772 [3.2.1.20]
ORF04246	8491 & 8492	similar to melibiose carrier protein
ORF04247	8493 & 8494	RhuM (partial)
ORF04248	8495 & 8496	membrane protein
ORF04249	8497 & 8498	Lipoprotein-28 precursor (hlpA)
ORF04250	8499 & 8500	conserved hypothetical protein
ORF04251	8501 & 8502	putative transport protein
ORF04252	8503 & 8504	Protein of unknown function (DUF1198) superfamily
ORF04253	8505 & 8506	xanthine-uracil permease family protein subfamily
ORF04254	8507 & 8508	adenine deaminase (ade) [3.5.4.2]
ORF04255	8509 & 8510	Hexose phosphate transport protein
ORF04256	8511 & 8512	Regulatory protein uhpC
ORF04257	8513 & 8514	Sensor protein uhpB
ORF04258	8515 & 8516	hypothetical protein
ORF04259	8517 & 8518	response regulator, positive activator of uhpT transcription

ORF04260	8519 & 8520	acetolactate synthase, small subunit, putative [2.2.1.6]
ORF04261	8521 & 8522	acetolactate synthase, large subunit, biosynthetic type (ilvB) [2.2.1.6]
ORF04262	8523 & 8524	Multidrug resistance protein D
ORF04263	8525 & 8526	f165 [1.-.-.-]
ORF04264	8527 & 8528	conserved hypothetical protein
ORF04265	8529 & 8530	Predicted membrane protein
ORF04266	8531 & 8532	probable sulfatase yidJ [3.1.6.-]
ORF04267	8533 & 8534	Putative sulfatase yidJ [3.1.6.-]
ORF04268	8535 & 8536	Na+-myo-inositol cotransporter
ORF04269	8537 & 8538	msm operon regulatory protein , putative
ORF04270	8539 & 8540	potassium uptake protein TrkA, putative
ORF04271	8541 & 8542	heat shock protein
ORF04272	8543 & 8544	heat shock protein
ORF04273	8545 & 8546	hypothetical protein
ORF04274	8547 & 8548	o135 protein
ORF04275	8549 & 8550	f416
ORF04276	8551 & 8552	MFS transporter, phthalate permease family
ORF04277	8553 & 8554	conserved hypothetical protein
ORF04278	8555 & 8556	mandelate racemase-muconate lactonizing enzyme family protein (partial) [4.2.1.6]
ORF04279	8557 & 8558	4-hydroxy-2-oxoglutarate aldolase-2-dehydro-3-deoxyphosphogluconate [4.1.2.21]
ORF04280	8559 & 8560	2-dehydro-3-deoxygalactonate kinase [2.7.1.58]
ORF04281	8561 & 8562	transcriptional repressor for galactonate utilization (GntR family) (AF096293)
ORF04282	8563 & 8564	probable replicase Z5187
ORF04283	8565 & 8566	Cof family protein
ORF04284	8567 & 8568	Bacterial protein of unknown function (DUF937) family
ORF04285	8569 & 8570	DNA gyrase, B subunit (gyrB) [5.99.1.3]
ORF04286	8571 & 8572	DNA replication and repair protein recF [similarity]
ORF04287	8573 & 8574	DNA polymerase III, beta subunit (dnaN) [2.7.7.7]
ORF04288	8575 & 8576	chromosomal replication initiator protein DnaA (dnaA)
ORF04289	8577 & 8578	ribosomal protein L34 (rpmH)
ORF04290	8579 & 8580	ribonuclease P protein component (rnpA) [3.1.26.5]
ORF04291	8581 & 8582	conserved hypothetical protein TIGR00278
ORF04292	8583 & 8584	Inner membrane protein oxaA (IMP)
ORF04293	8585 & 8586	tRNA modification GTPase TrmE (trmE)
ORF04294	8587 & 8588	tryptophanase (TNase) [4.1.99.1]
ORF04295	8589 & 8590	Low affinity tryptophan permease
ORF04296	8591 & 8592	similar to drug resistance translocases
ORF04297	8593 & 8594	transcriptional regulator, LysR family
ORF04298	8595 & 8596	hypothetical protein
ORF04299	8597 & 8598	o252
ORF04300	8599 & 8600	YieF (putative)
ORF04301	8601 & 8602	f445
ORF04302	8603 & 8604	haloacid dehalogenase-like hydrolase, putative
ORF04303	8605 & 8606	conserved hypothetical protein
ORF04304	8607 & 8608	pyrimidine-specific nucleoside hydrolase [3.5.99.6]
ORF04305	8609 & 8610	Putative esterase family, putative
ORF04306	8611 & 8612	putative xylanase
ORF04307	8613 & 8614	f538
ORF04308	8615 & 8616	6-phospho-beta-glucosidase bglB [3.2.1.86]
ORF04309	8617 & 8618	PTS system, beta-glucoside-specific IIABC component
ORF04310	8619 & 8620	Cryptic beta-glucoside bgl operon Antiterminator
ORF04311	8621 & 8622	phosphate transport system regulatory protein PhoU (phoU)

ORF04312	8623 & 8624	phosphate ABC transporter, ATP-binding protein (pstB) [3.6.3.27]
ORF04313	8625 & 8626	phosphate ABC transporter, permease protein PstA (pstA)
ORF04314	8627 & 8628	phosphate ABC transporter, permease protein PstC (pstC)
ORF04315	8629 & 8630	phosphate ABC transporter, phosphate-binding protein (pstS)
ORF04316	8631 & 8632	glucosamine--fructose-6-phosphate aminotransferase, isomerizing (glmS) [2.6.1.16]
ORF04317	8633 & 8634	UDP-N-acetylglucosamine pyrophosphorylase (glmU) [2.7.7.23]
ORF04318	8635 & 8636	ATP synthase F1, epsilon subunit (atpC) [3.6.3.14]
ORF04319	8637 & 8638	ATP synthase F1, beta subunit (atpD) [3.6.3.14]
ORF04320	8639 & 8640	ATP synthase F1, gamma subunit (atpG) [3.6.3.14]
ORF04321	8641 & 8642	ATP synthase F1, alpha subunit (atpA) [3.6.3.14]
ORF04322	8643 & 8644	ATP synthase F1, delta subunit (atpH) [3.6.3.14]
ORF04323	8645 & 8646	ATP synthase F0, B subunit (atpF) [3.6.3.14]
ORF04324	8647 & 8648	conserved hypothetical protein
ORF04325	8649 & 8650	ATP synthase F0, C subunit [3.6.3.14]
ORF04326	8651 & 8652	ATP synthase F0, A subunit (atpB) [3.6.3.14]
ORF04327	8653 & 8654	ATP synthase F0, I subunit (atpI) [3.6.3.14]
ORF04328	8655 & 8656	methyltransferase GidB (gidB) [2.1.-.-]
ORF04329	8657 & 8658	glucose-inhibited division protein A (gidA)
ORF04330	8659 & 8660	Protein mioC (mioC)
ORF04331	8661 & 8662	transcriptional regulator, AsnC Family (asnC)
ORF04332	8663 & 8664	aspartate--ammonia ligase (asnA) [6.3.1.1]
ORF04333	8665 & 8666	conserved hypothetical protein
ORF04334	8667 & 8668	unnamed protein product
ORF04335	8669 & 8670	potassium uptake protein (kup)
ORF04336	8671 & 8672	high affinity ribose transport protein rbsD
ORF04337	8673 & 8674	ribose ABC transporter, ATP-binding protein (atp_bind)
ORF04338	8675 & 8676	ribose ABC transporter, permease protein (rbsC)
ORF04339	8677 & 8678	ribose ABC transporter, periplasmic D-ribose-binding protein
ORF04340	8679 & 8680	ribokinase (rbsK) [2.7.1.15]
ORF04341	8681 & 8682	drug resistance transporter, EmrB-QacA family
ORF04342	8683 & 8684	regulator for rbs operon
ORF04343	8685 & 8686	ProP protein
ORF04344	8687 & 8688	yieP gene product (AF096293)
ORF04345	8689 & 8690	hypothetical protein
ORF04346	8691 & 8692	Transcription regulator
ORF04347	8693 & 8694	o137 (YIFE)
ORF04348	8695 & 8696	Mg chelatase-related protein
ORF04349	8697 & 8698	hypothetical protein
ORF04350	8699 & 8700	acetolactate synthase, large subunit, biosynthetic type (ilvB) [2.2.1.6]
ORF04351	8701 & 8702	acetolactate synthase II small chain (ALS-II) [4.1.3.18]
ORF04352	8703 & 8704	branched-chain amino acid aminotransferase (ilvE) [2.6.1.42]
ORF04353	8705 & 8706	dihydroxy-acid dehydratase (ilvD) [4.2.1.9]
ORF04354	8707 & 8708	threonine ammonia-lyase, biosynthetic (ilvA) [4.3.1.19]
ORF04355	8709 & 8710	transcriptional regulator, LysR family, putative
ORF04356	8711 & 8712	Ketol-acid reductoisomerase (ILVC) [1.1.1.86]
ORF04357	8713 & 8714	peptidylprolyl isomerase (SPP39159) [5.2.1.8]
ORF04358	8715 & 8716	ATP-dependent DNA helicase Rep (rep) [3.6.1.-]
ORF04359	8717 & 8718	Guanosine-5'-triphosphate,3'-diphosphate pyrophosphatase [3.6.1.40]
ORF04360	8719 & 8720	rhlB protein (RHLB) [3.6.1.-]
ORF04361	8721 & 8722	thioredoxin 1
ORF04362	8723 & 8724	transcription termination factor Rho (rho)
ORF04363	8725 & 8726	conserved hypothetical protein

ORF04364	8727 & 8728	undecaprenyl-phosphate alpha-N-acetylglucosaminyl 1-phosphatetransferase (wecA) [2.7.8.-]
ORF04365	8729 & 8730	Lipopolysaccharide biosynthesis protein wzzE
ORF04366	8731 & 8732	UDP-N-acetylglucosamine 2-epimerase [5.1.3.14]
ORF04367	8733 & 8734	UDP-N-acetyl-D-mannosamine dehydrogenase (ECA) [1.1.1.-]
ORF04368	8735 & 8736	dTDP-glucose 4,6-dehydratase (rfbB) [4.2.1.46]
ORF04369	8737 & 8738	glucose-1-phosphate thymidylyltransferase (rfbA) [2.7.7.24]
ORF04370	8739 & 8740	TDP-D-fucosamine acetyltransferase (wecD)
ORF04371	8741 & 8742	Lipopolysaccharide biosynthesis protein rffA (WECE) [4.2.1.-]
ORF04372	8743 & 8744	WzxE protein (WZXE)
ORF04373	8745 & 8746	TDP-Fuc4NAc:lipid II Fuc4Nac transferase (wecF) [2.4.1.-]
ORF04374	8747 & 8748	ECA biosynthesis protein WzyE (wzyE)
ORF04375	8749 & 8750	possibly rffM (ECA) [2.4.1.-]
ORF04376	8751 & 8752	hypothetical protein
ORF04377	8753 & 8754	similar to several amino acid transport proteins (o461)
ORF04378	8755 & 8756	tyrosine recombinase XerC (xerC)
ORF04379	8757 & 8758	o238 (YIGB)
ORF04380	8759 & 8760	tyrosine recombinase XerC (xerC)
ORF04381	8761 & 8762	o238 (YIGB)
ORF04382	8763 & 8764	arylsulfatase regulator
ORF04383	8765 & 8766	Arylsulfatase [3.1.6.1]
ORF04384	8767 & 8768	hemY protein (hemY)
ORF04385	8769 & 8770	uroporphyrinogen III methylase (HEMX) [2.1.1.107]
ORF04386	8771 & 8772	uroporphyrinogen-III synthase (hemD) [4.2.1.75]
ORF04387	8773 & 8774	porphobilinogen deaminase (hemC) [2.5.1.61]
ORF04388	8775 & 8776	adenylate cyclase, class-I (cyaA) [4.6.1.1]
ORF04389	8777 & 8778	CyaY protein (CYAY)
ORF04390	8779 & 8780	possible exported protein
ORF04391	8781 & 8782	lipoprotein, putative
ORF04392	8783 & 8784	Hypothetical lipoprotein yifL precursor-related protein
ORF04393	8785 & 8786	diaminopimelate epimerase (dapF) [5.1.1.7]
ORF04394	8787 & 8788	Protein of unknown function, DUF484 superfamily
ORF04395	8789 & 8790	tyrosine recombinase XerC (xerC)
ORF04396	8791 & 8792	o238 (YIGB)
ORF04397	8793 & 8794	DNA helicase II (uvrD) [3.6.1.-]
ORF04398	8795 & 8796	Protein of unknown function superfamily
ORF04399	8797 & 8798	yigE protein
ORF04400	8799 & 8800	hypothetical protein
ORF04401	8801 & 8802	magnesium and cobalt transport protein CorA (corA)
ORF04402	8803 & 8804	Enterobacterial putative membrane protein (DUF943) superfamily
ORF04403	8805 & 8806	conserved hypothetical protein
ORF04404	8807 & 8808	hypothetical protein
ORF04405	8809 & 8810	rarD protein (rarD)
ORF04406	8811 & 8812	f161 (YIGI)
ORF04407	8813 & 8814	phospholipase A1 family protein, interruption [3.1.1.32]
ORF04408	8815 & 8816	ATP-dependent DNA helicase RecQ (recQ) [3.6.1.-]
ORF04409	8817 & 8818	threonine efflux protein
ORF04410	8819 & 8820	transporter, LysE family
ORF04411	8821 & 8822	Lysophospholipase L2 (Lecithinase B) (PLDB) [3.1.1.5]
ORF04412	8823 & 8824	Cof protein
ORF04413	8825 & 8826	HTH-type transcriptional regulator metR (METR)
ORF04414	8827 & 8828	Hypothetical membrane protein yigM

ORF04415	8829 & 8830	5methyltetrahydropteroyltriglutamate--homocysteine S-methyltransferase (metE) [2.1.1.14]
ORF04416	8831 & 8832	conserved hypothetical protein
ORF04417	8833 & 8834	conserved hypothetical protein
ORF04418	8835 & 8836	6-phospho-3-hexuloisomerase (PHI)
ORF04419	8837 & 8838	PTS system, glucose-specific IIBC component (ptsG) [2.7.1.69]
ORF04420	8839 & 8840	transketolase (tkt) [2.2.1.1]
ORF04421	8841 & 8842	transcriptional regulator, rpiR family domain protein
ORF04422	8843 & 8844	transcriptional regulator, LysR family
ORF04423	8845 & 8846	cytosine transporter, putative
ORF04424	8847 & 8848	amidase family protein, putative
ORF04425	8849 & 8850	Carbamate kinase-like protein yahI [2.7.2.2]
ORF04426	8851 & 8852	YahG-YIbE-like protein
ORF04427	8853 & 8854	YahF-FdrA-like protein
ORF04428	8855 & 8856	conserved hypothetical protein
ORF04429	8857 & 8858	isochorismatase family protein
ORF04430	8859 & 8860	hypothetical protein
ORF04431	8861 & 8862	Putative carboxymethylenebutenolidase
ORF04432	8863 & 8864	conserved hypothetical protein
ORF04433	8865 & 8866	uridine phosphorylase (udp) [2.4.2.3]
ORF04434	8867 & 8868	tricarboxylate transport protein TctA, putative
ORF04435	8869 & 8870	conserved hypothetical protein
ORF04436	8871 & 8872	Bordetella uptake gene (bug) product superfamily
ORF04437	8873 & 8874	4-hydroxy-2-oxoglutarate aldolase-2-dehydro-3-deoxyphosphogluconate
ORF04438	8875 & 8876	2-dehydro-3-deoxygalactonate kinase
ORF04439	8877 & 8878	transcriptional regulator, IclR family
ORF04440	8879 & 8880	DNA recombination protein rmuC
ORF04441	8881 & 8882	Ubiquinone-menaquinone biosynthesis methyltransferase ubiE(EC 2.1.1.-) (UBIE) [2.1.1.-]
ORF04442	8883 & 8884	unnamed protein product
ORF04443	8885 & 8886	2-polyprenylphenol 6-hydroxylase (ubiB) [1.14.13.-]
ORF04444	8887 & 8888	o261 (YIGT)
ORF04445	8889 & 8890	o261
ORF04446	8891 & 8892	Sec-independent protein translocase TatC (tatC)
ORF04447	8893 & 8894	tatD gene product (YIGW) [3.1.21.-]
ORF04448	8895 & 8896	transcriptional activator RfaH (rfaH)
ORF04449	8897 & 8898	3-octaprenyl-4-hydroxybenzoate carboxy-lyase (Polyprenylp-hydroxybenzoate decarboxylase) (YIGC) [4.1.1.-]
ORF04450	8899 & 8900	NAD(P)H-flavin reductase
ORF04451	8901 & 8902	conserved hypothetical protein
ORF04452	8903 & 8904	acetyl-CoA C-acyltransferase FadA (fadA) [2.3.1.16]
ORF04453	8905 & 8906	fatty oxidation complex, alpha subunit FadB (fadB) [4.2.1.17 5.3.3.8 1.1.1.35 5.1.2.3]
ORF04454	8907 & 8908	unnamed protein product; pepQ product, proline dipeptidase (PEPQ) [3.4.13.9]
ORF04455	8909 & 8910	conserved hypothetical protein TIGR00257
ORF04456	8911 & 8912	bis(5`-nucleosyl)-tetraphosphatase, symmetrical-Trk system potassium uptake protein TrkG, fusion
ORF04457	8913 & 8914	protoporphyrin oxidase
ORF04458	8915 & 8916	hypothetical protein
ORF04459	8917 & 8918	molybdopterin-guanine dinucleotide biosynthesis protein B (mobB)
ORF04460	8919 & 8920	Molybdopterin-guanine dinucleotide biosynthesis protein A
ORF04461	8921 & 8922	Protein yihD

ORF04462	8923 & 8924	YihE
ORF04463	8925 & 8926	Thiol:disulfide interchange protein dsbA precursor (por) [5.3.4.1]
ORF04464	8927 & 8928	Bacterial protein of unknown function (DUF945) superfamily
ORF04465	8929 & 8930	Acyltransferase domain protein
ORF04466	8931 & 8932	DNA polymerase I (POL I) (polA) [2.7.7.7]
ORF04467	8933 & 8934	essential GTPase for cell cycle
ORF04468	8935 & 8936	neutrophil protein
ORF04469	8937 & 8938	hypothetical protein
ORF04470	8939 & 8940	oxygen-independent coproporphyrinogen III oxidase (hemN)
ORF04471	8941 & 8942	hypothetical protein
ORF04472	8943 & 8944	nitrogen regulation protein NR(I) (ntrC)
ORF04473	8945 & 8946	Nitrogen regulation protein NR(II) [2.7.3.-]
ORF04474	8947 & 8948	glutamine synthetase, type I (glnA) [6.3.1.2]
ORF04475	8949 & 8950	GTP-binding protein TypA (typA)
ORF04476	8951 & 8952	hypothetical protein
ORF04477	8953 & 8954	Glycerol-3-phosphate regulon repressor
ORF04478	8955 & 8956	Hypothetical sugar kinase yihV
ORF04479	8957 & 8958	3-hydroxyisobutyrate dehydrogenase
ORF04480	8959 & 8960	Tagatose 1,6-diphosphate aldolase 2 (Tagatose-bisphosphate aldolase 2) (D-tagatose-1,6-bisphosphate aldolase 2) [4.1.-.-]
ORF04481	8961 & 8962	2,3-butanediol dehydrogenase, putative
ORF04482	8963 & 8964	major facilitator family transporter, truncation, putative
ORF04483	8965 & 8966	major facilitator family transporter
ORF04484	8967 & 8968	Aldose 1-epimerase superfamily
ORF04485	8969 & 8970	haloacid dehalogenase-like hydrolase, putative
ORF04486	8971 & 8972	ribonuclease BN, putative [3.1.-.-]
ORF04487	8973 & 8974	D-tyrosyl-tRNA(Tyr) deacylase (dtd) [3.1.-.-]
ORF04488	8975 & 8976	conserved membrane protein [2.3.1.18]
ORF04489	8977 & 8978	lipase, GDXG family VCA0490
ORF04490	8979 & 8980	transcriptional regulator, Cro-CI family
ORF04491	8981 & 8982	Ribbon-helix-helix protein, copG family domain protein
ORF04492	8983 & 8984	formate dehydrogenase accessory protein FdhE (fdhE)
ORF04493	8985 & 8986	formate dehydrogenase, gamma subunit [1.2.1.2]
ORF04494	8987 & 8988	formate dehydrogenase, beta subunit (FdxH) [1.2.1.2]
ORF04495	8989 & 8990	formate dehydrogenase, alpha subunit [1.2.1.2]
ORF04496	8991 & 8992	formate dehydrogenase, alpha subunit, selenocysteine-containing [1.2.1.2]
ORF04497	8993 & 8994	formate dehydrogenase family accessory protein FdhD (fdhD)
ORF04498	8995 & 8996	conserved hypothetical protein
ORF04499	8997 & 8998	conserved hypothetical protein
ORF04500	8999 & 9000	Putative glycoporin
ORF04501	9001 & 9002	B. subtilis YulD protein homolog lin2978 , putative
ORF04502	9003 & 9004	Rhamnulose-1-phosphate aldolase
ORF04503	9005 & 9006	L-rhamnose isomerase (rhaA) [5.3.1.14]
ORF04504	9007 & 9008	sugar kinase [2.7.1.5]
ORF04505	9009 & 9010	hypothetical protein
ORF04506	9011 & 9012	L-rhamnose operon Regulatory protein rhaS
ORF04507	9013 & 9014	positive regulator for rhaRS operon
ORF04508	9015 & 9016	L-rhamnose-proton symport
ORF04509	9017 & 9018	Superoxide dismutase [Mn] (sodA) [1.15.1.1]
ORF04510	9019 & 9020	conserved hypothetical protein
ORF04511	9021 & 9022	2-keto-3-deoxygluconate transporter (kdgT)

ORF04512	9023 & 9024	MOSC domain protein
ORF04513	9025 & 9026	Sensor protein cpxA [2.7.3.-]
ORF04514	9027 & 9028	Transcriptional Regulatory protein cpxR
ORF04515	9029 & 9030	Periplasmic protein cpxP precursor
ORF04516	9031 & 9032	protein p34
ORF04517	9033 & 9034	6-phosphofructokinase I
ORF04518	9035 & 9036	Sulfate-binding protein precursor
ORF04519	9037 & 9038	CDP-diacylglycerol pyrophosphatase
ORF04520	9039 & 9040	triosephosphate isomerase (tpiA) [5.3.1.1]
ORF04521	9041 & 9042	Protein of unknown function (DUF1454) superfamily
ORF04522	9043 & 9044	conserved membrane protein
ORF04523	9045 & 9046	conserved hypothetical protein superfamily
ORF04524	9047 & 9048	Universal stress protein D (UspA)
ORF04525	9049 & 9050	Ferredoxin--NADP reductase (DA1) [1.18.1.2]
ORF04526	9051 & 9052	fructose-1,6-bisphosphatase, class II (glpX) [3.1.3.11]
ORF04527	9053 & 9054	glycerol kinase (glpK) [2.7.1.30]
ORF04528	9055 & 9056	Glycerol uptake facilitator protein (Aquaglyceroporin) (glpF)
ORF04529	9057 & 9058	Protein of unknown function (DUF904) superfamily
ORF04530	9059 & 9060	regulator of ribonuclease activity A (rraA)
ORF04531	9061 & 9062	1,4-dihydroxy-2-naphthoate octaprenyltransferase (menA) [2.5.-.-]
ORF04532	9063 & 9064	heat shock protein HslVU, ATPase subunit HslU (hslU)
ORF04533	9065 & 9066	peptidase component of the HslUV protease
ORF04534	9067 & 9068	cell division protein FtsN (ftsN)
ORF04535	9069 & 9070	regulator for deo operon, udp, cdd, tsx
ORF04536	9071 & 9072	Primosomal protein N'
ORF04537	9073 & 9074	ribosomal protein L31 (rpmE)
ORF04538	9075 & 9076	Protein of unknown function (DUF1105) superfamily
ORF04539	9077 & 9078	Met repressor
ORF04540	9079 & 9080	O-succinylhomoserine (thiol)-lyase (metB) [2.5.1.48]
ORF04541	9081 & 9082	AKII-HDII protein [2.7.2.4]
ORF04542	9083 & 9084	Nucleoside-specific channel-forming protein tsx precursor
ORF04543	9085 & 9086	5-nucleotidase family protein, putative
ORF04544	9087 & 9088	5'-nucleotidase, C-terminal domain protein
ORF04545	9089 & 9090	5-nucleotidase, putative
ORF04546	9091 & 9092	conserved hypothetical protein
ORF04547	9093 & 9094	5-nucleotidase family protein, putative
ORF04548	9095 & 9096	5,10-methylenetetrahydrofolate reductase (metF) [1.7.99.5]
ORF04549	9097 & 9098	catalase-peroxidase HPI (katG) [1.11.1.6]
ORF04550	9099 & 9100	Hypothetical transport protein yijE
ORF04551	9101 & 9102	Protein of unknown function (DUF1287) superfamily
ORF04552	9103 & 9104	conserved hypothetical protein
ORF04553	9105 & 9106	Glycerol dehydrogenase (NAD) [1.1.1.6]
ORF04554	9107 & 9108	transaldolase, putative
ORF04555	9109 & 9110	Phosphoenolpyruvate-protein phosphotransferase ptsA [2.7.3.9]
ORF04556	9111 & 9112	PTS system, fructose-specific IIABC components
ORF04557	9113 & 9114	PTS system, fructose-like-2 IIB component 1 (Phosphotransferase enzymeII, B component) [2.7.1.69]
ORF04558	9115 & 9116	pyruvate formate-lyase [2.3.1.54]
ORF04559	9117 & 9118	similar to E.coli pyruvate formate-lyase activating enzyme
ORF04560	9119 & 9120	AraC-type DNA-binding domain-containing protein
ORF04561	9121 & 9122	PTS system fructose-like IIB component 2 (phosphotransfer) [2.7.1.69]
ORF04562	9123 & 9124	integral membrane protein, putative

ORF04563	9125 & 9126	phosphoenolpyruvate carboxylase (ppc) [4.1.1.31]
ORF04564	9127 & 9128	acetylornithine deacetylase (ArgE) (argE) [3.5.1.16]
ORF04565	9129 & 9130	N-acetyl-gamma-glutamyl-phosphate reductase (argC) [1.2.1.38]
ORF04566	9131 & 9132	acetylglutamate kinase (argB) [2.7.2.8]
ORF04567	9133 & 9134	argininosuccinate lyase (argH) [4.3.2.1]
ORF04568	9135 & 9136	Starvation sensing protein rspA
ORF04569	9137 & 9138	major facilitator family transporter
ORF04570	9139 & 9140	soluble pyridine nucleotide transhydrogenase (STH) [1.6.1.1]
ORF04571	9141 & 9142	Hydrogen peroxide-inducible genes activator (oxyR)
ORF04572	9143 & 9144	hippurate hydolase
ORF04573	9145 & 9146	major facilitator family transporter
ORF04574	9147 & 9148	transcriptional regulator, TetR family
ORF04575	9149 & 9150	ATPase of the AAA+ class
ORF04576	9151 & 9152	tRNA (uracil-5-)-methyltransferase (trmA) [2.1.1.35]
ORF04577	9153 & 9154	TonB-dependent vitamin B12 receptor (btuB)
ORF04578	9155 & 9156	glutamate racemase (murI) [5.1.1.3]
ORF04579	9157 & 9158	hypothetical protein
ORF04580	9159 & 9160	UDP-N-acetylenolpyruvoylglucosamine reductase (murB) [1.1.1.158]
ORF04581	9161 & 9162	BirA bifunctional protein (BIRA) [6.3.4.15]
ORF04582	9163 & 9164	pantothenate kinase (coaA) [2.7.1.33]
ORF04583	9165 & 9166	translation elongation factor EF-Tu.B
ORF04584	9167 & 9168	translation elongation factor EF-Tu.B
ORF04585	9169 & 9170	protein chain elongation factor EF-Tu
ORF04586	9171 & 9172	preprotein translocase SecE subunit (SecE)
ORF04587	9173 & 9174	transcription termination-antitermination factor NusG (nusG)
ORF04588	9175 & 9176	ribosomal protein L11 (rplK)
ORF04589	9177 & 9178	ribosomal protein L1 (rplA)
ORF04590	9179 & 9180	50S ribosomal subunit protein L10 (RPLJ)
ORF04591	9181 & 9182	ribosomal protein L7-L12 (rplL)
ORF04592	9183 & 9184	DNA-directed RNA polymerase, beta subunit (rpoB) [2.7.7.6]
ORF04593	9185 & 9186	DNA-directed RNA polymerase, beta' subunit (rpoC) [2.7.7.6]
ORF04594	9187 & 9188	thiazole biosynthesis protein ThiH (thiH)
ORF04595	9189 & 9190	4-methyl-5-(beta-hydroxyethyl)thiazole monophosphate synthesis protein ThiG
ORF04596	9191 & 9192	thiamine biosynthesis protein ThiS (thiS)
ORF04597	9193 & 9194	thiazole biosynthesis adenylyltransferase ThiF (thiF)
ORF04598	9195 & 9196	thiamine-phosphate pyrophosphorylase (thiE) [2.5.1.3]
ORF04599	9197 & 9198	Thiamine biosynthesis protein thiC
ORF04600	9199 & 9200	Regulator of sigma D
ORF04601	9201 & 9202	MutT-nudix family protein [3.6.1.-]
ORF04602	9203 & 9204	uroporphyrinogen decarboxylase (hemE) [4.1.1.37]
ORF04603	9205 & 9206	endonuclease V (deoxyinosine 3endoduclease)
ORF04604	9207 & 9208	Protein of unknown function, DUF superfamily
ORF04605	9209 & 9210	DNA-binding protein HU-alpha (NS2) (HU-2) (HU)
ORF04606	9211 & 9212	unnamed protein product
ORF04607	9213 & 9214	Zinc resistance-associated protein precursor
ORF04608	9215 & 9216	sensor kinase for HydG, hydrogenase 3 activity [2.7.3.-]
ORF04609	9217 & 9218	Transcriptional Regulatory protein zraR (sigma54)
ORF04610	9219 & 9220	phosphoribosylamine--glycine ligase (purD) [6.3.4.13]
ORF04611	9221 & 9222	bifunctional purine biosynthesis protein PurH (purH)
ORF04612	9223 & 9224	conserved hypothetical protein
ORF04613	9225 & 9226	hypothetical protein
ORF04614	9227 & 9228	conserved hypothetical protein

ORF04615	9229 & 9230	acetyltransferase, GNAT family (putative) [2.3.1.-]
ORF04616	9231 & 9232	homoserine O-succinyltransferase (metA) [2.3.1.46]
ORF04617	9233 & 9234	malate synthase A (aceB) [2.3.3.9]
ORF04618	9235 & 9236	isocitrate lyase (aceA) [4.1.3.1]
ORF04619	9237 & 9238	Isocitrate dehydrogenase kinase-phosphatase(EC 3.1.3.-) (IDH kinase-phosphatase) (IDHK-P) [2.7.1.116]
ORF04620	9239 & 9240	transcriptional regulator, putative
ORF04621	9241 & 9242	hypothetical protein
ORF04622	9243 & 9244	5-methyltetrahydrofolate--homocysteine methyltransferase (metH) [2.1.1.13]
ORF04623	9245 & 9246	conserved hypothetical protein
ORF04624	9247 & 9248	Na-Pi-cotransporter II-related protein, putative
ORF04625	9249 & 9250	Peptidase E (Alpha-aspartyl dipeptidase) (Asp-specificdipeptidase) (Dipeptidase E) (alpha) [3.4.13.21]
ORF04626	9251 & 9252	L-sorbose 1-phosphate reductase [1.1.1.-]
ORF04627	9253 & 9254	PTS system, mannose-specific IID component
ORF04628	9255 & 9256	PTS system, mannose-specific IIC component [2.7.1.69]
ORF04629	9257 & 9258	sorbose-permease PTS system IIB component (EIII-MAN) [2.7.1.69]
ORF04630	9259 & 9260	PTS system, sorbose-specific IIA component (EIIA-Sor) (Sorbose-permease IIA component) (Phosphotransferase enzyme II, A component)(EC 2.7.1.69) (EIII-F-Sor) [2.7.1.69]
ORF04631	9261 & 9262	D-glucitol-6-phosphate dehydrogenase [1.1.1.140]
ORF04632	9263 & 9264	Putative transcriptional regulator of sorbose uptake and
ORF04633	9265 & 9266	RNA pseudouridylate synthase family protein [4.2.1.70]
ORF04634	9267 & 9268	conserved hypothetical protein
ORF04635	9269 & 9270	asparate kinase, monofunctional class [2.7.2.4]
ORF04636	9271 & 9272	glucose-6-phosphate isomerase (pgi) [5.3.1.9]
ORF04637	9273 & 9274	conserved hypothetical protein
ORF04638	9275 & 9276	lipoprotein, putative
ORF04639	9277 & 9278	Protein of unknown function (DUF1017) superfamily
ORF04640	9279 & 9280	otnG protein (o698)
ORF04641	9281 & 9282	conserved hypothetical protein
ORF04642	9283 & 9284	PsiE protein homolog
ORF04643	9285 & 9286	Maltose transport system permease protein malG (malG)
ORF04644	9287 & 9288	Maltose transport system permease protein malF (membrane)
ORF04645	9289 & 9290	Maltose-binding periplasmic protein precursor
ORF04646	9291 & 9292	Maltose-maltodextrin transport ATP-binding protein malK
ORF04647	9293 & 9294	Maltoporin precursor (Maltose-inducible porin) (malL)
ORF04648	9295 & 9296	Maltose operon periplasmic protein precursor (MalM) superfamily
ORF04649	9297 & 9298	conserved hypothetical protein
ORF04650	9299 & 9300	chorismate lyase [4.-.-.-]
ORF04651	9301 & 9302	4-hydroxybenzoate polyprenyl transferase (ubiA) [2.5.1.-]
ORF04652	9303 & 9304	glycerol-3-phosphate O-acyltransferase [2.3.1.15]
ORF04653	9305 & 9306	diacylglycerol kinase (DGK) [2.7.1.107]
ORF04654	9307 & 9308	LexA repressor (lexA) [3.4.21.88]
ORF04655	9309 & 9310	DNA-damage-inducible protein F, truncation
ORF04656	9311 & 9312	Protein yjbJ-related protein
ORF04657	9313 & 9314	Zinc uptake regulation protein
ORF04658	9315 & 9316	tRNA-dihydrouridine synthase A [1.-.-.-]
ORF04659	9317 & 9318	conserved hypothetical protein
ORF04660	9319 & 9320	quinone oxidoreductase
ORF04661	9321 & 9322	Putative oxidoreductase
ORF04662	9323 & 9324	metabolite-proton symporter

ORF04663	9325 & 9326	enoyl-CoA hydratase-isomerase family protein
ORF04664	9327 & 9328	acetyl-CoA-transferase subunit, putative [2.8.3.-]
ORF04665	9329 & 9330	LACI-FAMILY TRANSCRIPTION REGULATOR
ORF04666	9331 & 9332	replicative DNA helicase (dnaB) [3.6.1.-]
ORF04667	9333 & 9334	alanine racemase (alr) [5.1.1.1]
ORF04668	9335 & 9336	transporter, putative
ORF04669	9337 & 9338	NadR homolog
ORF04670	9339 & 9340	Aromatic-amino-acid aminotransferase
ORF04671	9341 & 9342	2-oxoglutarate dehydrogenase, E1 component (sucA) [1.2.4.2]
ORF04672	9343 & 9344	2-oxoglutarate dehydrogenase, E2 component, dihydrolipoamide succinyltransferase (sucB) [2.3.1.61]
ORF04673	9345 & 9346	dihydrolipoamide dehydrogenase (lpdA) [1.8.1.4]
ORF04674	9347 & 9348	Succinyl-CoA synthetase beta chain (AF326913) [6.2.1.5]
ORF04675	9349 & 9350	Succinyl-CoA synthetase alpha chain [6.2.1.5]
ORF04676	9351 & 9352	anion transporter family protein
ORF04677	9353 & 9354	two-component response regulator
ORF04678	9355 & 9356	Putative lactate dehydrogenase
ORF04679	9357 & 9358	Putative transport sensor protein
ORF04680	9359 & 9360	HAD superfamily (subfamily IIIB) phosphatase, TIGR01672 (AphA) [3.1.3.-]
ORF04681	9361 & 9362	conserved hypothetical protein TIGR00149
ORF04682	9363 & 9364	Protein yjbR
ORF04683	9365 & 9366	excinuclease ABC, A subunit (uvrA)
ORF04684	9367 & 9368	ssDNA-binding protein
ORF04685	9369 & 9370	conserved hypothetical protein
ORF04686	9371 & 9372	EAL domain protein
ORF04687	9373 & 9374	regulatory protein soxS
ORF04688	9375 & 9376	redox-sensitive transcriptional activator SoxR (soxR)
ORF04689	9377 & 9378	xanthine-uracil permease family protein
ORF04690	9379 & 9380	Na+-H+ antiporter
ORF04691	9381 & 9382	transcriptional regulator, LysR family, putative
ORF04692	9383 & 9384	conserved hypothetical protein
ORF04693	9385 & 9386	murein hydrolase exporter
ORF04694	9387 & 9388	LrgB-like family superfamily
ORF04695	9389 & 9390	Sodium,solute symporter family protein (PutP)
ORF04696	9391 & 9392	Protein of unknown function, DUF485 superfamily
ORF04697	9393 & 9394	acetate--CoA ligase (acsA) [6.2.1.1]
ORF04698	9395 & 9396	nitrite reductase (cytochrome; ammonia-forming) (nrfA) [1.7.2.2]
ORF04699	9397 & 9398	formate-dependent nitrite reductase NrfB
ORF04700	9399 & 9400	NrfC protein (NrfC) [1.-.-.-]
ORF04701	9401 & 9402	NrfD protein (NrfD) [1.-.-.-]
ORF04702	9403 & 9404	cytochrome c-type biogenesis protein CcmF (ccmF)
ORF04703	9405 & 9406	formate-dependent nitrite reductase
ORF04704	9407 & 9408	Formate-dependent nitrite reductase complex nrfG subunit (nrfF)
ORF04705	9409 & 9410	conserved hypothetical protein
ORF04706	9411 & 9412	glutamate-aspartate symport protein (gltP)
ORF04707	9413 & 9414	conserved hypothetical protein
ORF04708	9415 & 9416	ABC transporter, ATP-binding protein
ORF04709	9417 & 9418	ABC transporter, nucleotide binding-ATPase protein [dipeptide]
ORF04710	9419 & 9420	ABC transporter, permease protein (AE006058)
ORF04711	9421 & 9422	ABC transporter permease protein (AE005357)
ORF04712	9423 & 9424	ABC transporter, periplasmic oligo-dipeptide-nickel binding protein (AE005357)

ORF04713	9425 & 9426	formate dehydrogenase, alpha subunit [1.2.1.2]
ORF04714	9427 & 9428	formate dehydrogenase, alpha subunit, putative [1.2.1.2]
ORF04715	9429 & 9430	matches PS00443: Glutamine amidotransferases class-II active site; similar to Pseudomonas cepacia fusaric acid resistance protein FusA
ORF04716	9431 & 9432	Fusaric acid resistance protein conserved region family
ORF04717	9433 & 9434	HlyD family secretion protein, putative
ORF04718	9435 & 9436	conserved hypothetical protein
ORF04719	9437 & 9438	metallo-beta-lactamase superfamily protein
ORF04720	9439 & 9440	glucokinase (EC 2.7.1.2) , putative [2.7.1.2]
ORF04721	9441 & 9442	ribulose-phosphate 3-epimerase (rpe) [5.1.3.1]
ORF04722	9443 & 9444	ribose ABC transporter, permease protein (permease)
ORF04723	9445 & 9446	ribose ABC transporter, permease protein (ECOWU89)
ORF04724	9447 & 9448	D-allose transport ATP-binding protein alsA (aldose)
ORF04725	9449 & 9450	hypothetical protein
ORF04726	9451 & 9452	D-allose-binding periplasmic protein precursor (ALBP)
ORF04727	9453 & 9454	Transcriptional regulator, putative
ORF04728	9455 & 9456	hypothetical protein
ORF04729	9457 & 9458	ribose 5-phosphate isomerase B (rpiB) [5.3.1.6]
ORF04730	9459 & 9460	conserved hypothetical protein
ORF04731	9461 & 9462	PhnP protein (phnp)
ORF04732	9463 & 9464	PhnO protein
ORF04733	9465 & 9466	phosphonate metabolism protein-1,5-bisphosphokinase (PRPP-forming) PhnN (phnN)
ORF04734	9467 & 9468	phosphonate metabolism protein PhnM (phnM)
ORF04735	9469 & 9470	phosphonate C-P lyase system protein PhnL (phnL)
ORF04736	9471 & 9472	phosphonate C-P lyase system protein PhnK (phnK)
ORF04737	9473 & 9474	Phosphonate metabolism protein PhnJ
ORF04738	9475 & 9476	Bacterial phosphonate metabolism protein (PhnI)
ORF04739	9477 & 9478	Bacterial phosphonate metabolism protein (PhnH)
ORF04740	9479 & 9480	PhnG protein
ORF04741	9481 & 9482	phosphonates metabolism transcriptional regulator PhnF (phnF)
ORF04742	9483 & 9484	membrane channel protein component of Pn transporter
ORF04743	9485 & 9486	phosphonate ABC transporter, substrate-binding protein, putative
ORF04744	9487 & 9488	phosphonate ABC transporter, ATP-binding protein (phnC)
ORF04745	9489 & 9490	PhnB protein
ORF04746	9491 & 9492	alkylphosphonate utilization operon protein PhnA
ORF04747	9493 & 9494	conserved hypothetical protein
ORF04748	9495 & 9496	conserved hypothetical protein
ORF04749	9497 & 9498	amino acid MFS transporter (PPII)
ORF04750	9499 & 9500	Sensor protein basS-pmrB
ORF04751	9501 & 9502	Transcriptional Regulatory protein basR-pmrA
ORF04752	9503 & 9504	predicted membrane-associated, metal-dependent hydrolase
ORF04753	9505 & 9506	Arginine-agmatine antiporter
ORF04754	9507 & 9508	HTH-type transcriptional regulator adiY
ORF04755	9509 & 9510	arginine decarboxylase [4.1.1.19]
ORF04756	9511 & 9512	arginine decarboxylase adi, biodegradative (ldc) [4.1.1.19]
ORF04757	9513 & 9514	Melibiose operon regulatory protein (AF049243)
ORF04758	9515 & 9516	glycosyl hydrolase, family 4, putative [3.2.1.22]
ORF04759	9517 & 9518	membrane protein, putative
ORF04760	9519 & 9520	fumarate hydratase class I, anaerobic [4.2.1.2]
ORF04761	9521 & 9522	anaerobic C4-dicarboxylate membrane transporter
ORF04762	9523 & 9524	conserved hypothetical protein

ORF04763	9525 & 9526	response regulator VC1604 (partial)
ORF04764	9527 & 9528	Sensor protein dcuS [2.7.3.-]
ORF04765	9529 & 9530	hypothetical protein
ORF04766	9531 & 9532	YjdI-like protein
ORF04767	9533 & 9534	acetyltransferase, GNAT family (GNAT)
ORF04768	9535 & 9536	lysyl-tRNA synthetase (lysS) [6.1.1.6]
ORF04769	9537 & 9538	PTR2-family transport protein STY0750 (POT)
ORF04770	9539 & 9540	CadA (ldc) [4.1.1.18]
ORF04771	9541 & 9542	transport of lysine-cadaverine
ORF04772	9543 & 9544	transcriptional activator
ORF04773	9545 & 9546	hypothetical protein
ORF04774	9547 & 9548	transcriptional regulator, TetR family domain protein, putative
ORF04775	9549 & 9550	Thiol:disulfide interchange protein dsbD precursor (dsbD) [1.8.1.8]
ORF04776	9551 & 9552	divalent cation tolerance protein cytochrome c biogenesis
ORF04777	9553 & 9554	Anaerobic C4-dicarboxylate transporter dcuA (DcuA)
ORF04778	9555 & 9556	aspartate ammonia-lyase (aspA) [4.3.1.1]
ORF04779	9557 & 9558	suppressor of F exclusion of bacteriophage T7
ORF04780	9559 & 9560	Amino acid permease superfamily
ORF04781	9561 & 9562	chaperonin, 10 kDa (groES)
ORF04782	9563 & 9564	chaperonin GroEL (groL)
ORF04783	9565 & 9566	conserved hypothetical protein
ORF04784	9567 & 9568	conserved hypothetical protein
ORF04785	9569 & 9570	lysine 2;3-aminomutase
ORF04786	9571 & 9572	translation elongation factor P (efp)
ORF04787	9573 & 9574	Entericidin B precursor-related protein
ORF04788	9575 & 9576	Entericidin B precursor-related protein
ORF04789	9577 & 9578	SugEL
ORF04790	9579 & 9580	Outer membrane lipoprotein blc precursor
ORF04791	9581 & 9582	beta-lactamase
ORF04792	9583 & 9584	fumarate reductase, anaerobic, membrane anchor polypeptide
ORF04793	9585 & 9586	Fumarate reductase subunit C (Fumarate reductase 15 kDa hydrophobicprotein) (frdC) [1.3.99.1]
ORF04794	9587 & 9588	fumarate reductase, anaerobic, iron-sulfur protein subunit
ORF04795	9589 & 9590	fumarate reductase, flavoprotein subunit (frdA) [1.3.99.1]
ORF04796	9591 & 9592	lysyl-tRNA synthetase-related protein GenX
ORF04797	9593 & 9594	amino acid permease
ORF04798	9595 & 9596	conserved hypothetical protein
ORF04799	9597 & 9598	conserved hypothetical protein
ORF04800	9599 & 9600	unnamed protein product
ORF04801	9601 & 9602	phosphatidylserine decarboxylase phospholipid synthesis
ORF04802	9603 & 9604	Predicted GTPases
ORF04803	9605 & 9606	Oligoribonuclease
ORF04804	9607 & 9608	unnamed protein product
ORF04805	9609 & 9610	predicted sugar kinase
ORF04806	9611 & 9612	conserved hypothetical protein TIGR00150
ORF04807	9613 & 9614	N-acetylmuramoyl-l-alanine amidase II a murein hydrolase
ORF04808	9615 & 9616	DNA mismatch repair protein mutL
ORF04809	9617 & 9618	tRNA delta(2)-isopentenylpyrophosphate transferase (miaA) [2.5.1.8]
ORF04810	9619 & 9620	host factor I (HF-I)
ORF04811	9621 & 9622	GTP-binding protein hflX
ORF04812	9623 & 9624	HflK protein (hflK) [3.4.-.-]
ORF04813	9625 & 9626	HflC protein (hflC)

ORF04814	9627 & 9628	hypothetical protein
ORF04815	9629 & 9630	conserved hypothetical protein
ORF04816	9631 & 9632	hypothetical protein
ORF04817	9633 & 9634	adenylosuccinate synthetase (purA) [6.3.4.4]
ORF04818	9635 & 9636	Predicted transcriptional regulator
ORF04819	9637 & 9638	ribonuclease R (rnr) [3.1.-.-]
ORF04820	9639 & 9640	RNA methyltransferase, TrmH family, group 3
ORF04821	9641 & 9642	conserved hypothetical protein
ORF04822	9643 & 9644	PspA-IM30 family protein
ORF04823	9645 & 9646	conserved hypothetical protein
ORF04824	9647 & 9648	predicted membrane protein (o132)
ORF04825	9649 & 9650	Protein of unknown function (DUF1190) superfamily
ORF04826	9651 & 9652	glutathionylspermidine synthase (O386)
ORF04827	9653 & 9654	fadE8
ORF04828	9655 & 9656	Protein of unknown function (DUF1471) superfamily
ORF04829	9657 & 9658	Protein of unknown function (DUF1471) family
ORF04830	9659 & 9660	Hydrolases of the alpha-beta superfamily (putative)
ORF04831	9661 & 9662	transcriptional regulator, DeoR family, putative
ORF04832	9663 & 9664	Predicted Zn-dependent hydrolase of the beta-lactamase fold
ORF04833	9665 & 9666	Putative sugar-specific permease, SgaT-UlaA superfamily, putative
ORF04834	9667 & 9668	putative IIB protein of PTS system
ORF04835	9669 & 9670	protein-Npi-phosphohistidine-sugar phosphotransferase (Ntr-type) [2.7.1.69]
ORF04836	9671 & 9672	hexulose-6-phosphate synthase (humps)
ORF04837	9673 & 9674	hexulose-6-phosphate isomerase, putative
ORF04838	9675 & 9676	AraD
ORF04839	9677 & 9678	Protein of unknown function (DUF1471) superfamily
ORF04840	9679 & 9680	30S ribosomal protein (rpS6)
ORF04841	9681 & 9682	Single-strand binding protein family
ORF04842	9683 & 9684	ribosomal protein S18 (rpsR)
ORF04843	9685 & 9686	ribosomal protein L9 (rplI)
ORF04844	9687 & 9688	conserved hypothetical protein
ORF04845	9689 & 9690	MFS transporter, phthalate permease family, putative
ORF04846	9691 & 9692	Putative oxidoreductase
ORF04847	9693 & 9694	acetyl-CoA-transferase subunit, putative
ORF04848	9695 & 9696	enoyl-CoA hydratase-isomerase FadB1x, putative [4.2.1.55]
ORF04849	9697 & 9698	3-dehydroshikimate dehydratase
ORF04850	9699 & 9700	conserved hypothetical protein
ORF04851	9701 & 9702	3-oxoacyl-(acyl-carrier-protein) reductase
ORF04852	9703 & 9704	Opacity-associated protein A superfamily
ORF04853	9705 & 9706	Putative conserved protein
ORF04854	9707 & 9708	FKBP-type 22 kDa peptidyl-prolyl cis-trans isomerase (rotamase) [5.2.1.8]
ORF04855	9709 & 9710	D-serine-D-alanine-glycine transporter
ORF04856	9711 & 9712	ScdA protein, putative
ORF04857	9713 & 9714	integral membrane protein (f324)
ORF04858	9715 & 9716	conserved hypothetical protein
ORF04859	9717 & 9718	Predicted transcriptional regulators
ORF04860	9719 & 9720	2',3'-cyclic-nucleotide 2'-phosphodiesterase (cpdB) [3.1.4.16]
ORF04861	9721 & 9722	conserved hypothetical protein YtfJ-family, TIGR01626
ORF04862	9723 & 9724	3'(2'),5'-bisphosphate nucleotidase (cysQ) [3.1.3.7]
ORF04863	9725 & 9726	Protein of unknown function (DUF1107) superfamily
ORF04864	9727 & 9728	Hypothetical UPF0053 protein ytfL
ORF04865	9729 & 9730	peptide methionine sulfoxide reductase

ORF04866	9731 & 9732	unnamed protein product
ORF04867	9733 & 9734	Family of unknown function (DUF490) family
ORF04868	9735 & 9736	Hypothetical UPF0131 protein ytfP
ORF04869	9737 & 9738	inorganic pyrophosphatase (ppa) [3.6.1.1]
ORF04870	9739 & 9740	periplasmic ribose-binding protein
ORF04871	9741 & 9742	ATP binding protein of ABC transporter
ORF04872	9743 & 9744	ribose ABC transporter, permease protein VCA0129
ORF04873	9745 & 9746	ribose ABC transporter, permease protein
ORF04874	9747 & 9748	fructose-1,6-bisphosphatase (fbp) [3.1.3.11]
ORF04875	9749 & 9750	conserved hypothetical protein
ORF04876	9751 & 9752	UDP-N-acetylmuramate:L-alanyl-gamma-D-glutamyl-meso-diaminopimelate ligase (mpl)
ORF04877	9753 & 9754	Hypothetical UPF0307 protein yjgA (x96 protein)
ORF04878	9755 & 9756	PmbA protein (pmbA)
ORF04879	9757 & 9758	Soluble cytochrome b562 precursor (562)
ORF04880	9759 & 9760	Anaerobic ribonucleoside-triphosphate reductase activating protein(EC 1.97.1.4) (Class III anaerobic ribonucleotide reductase smallcomponent) [1.97.1.4]
ORF04881	9761 & 9762	anaerobic ribonucleoside-triphosphate reductase [1.17.4.2]
ORF04882	9763 & 9764	hypothetical protein
ORF04883	9765 & 9766	alpha,alpha-phosphotrehalase (treC) [3.2.1.93]
ORF04884	9767 & 9768	PTS system, trehalose-specific IIBC component (treP) [2.7.1.69]
ORF04885	9769 & 9770	trehalose operon repressor (treR)
ORF04886	9771 & 9772	magnesium-translocating P-type ATPase (mgtA) [3.6.3.2]
ORF04887	9773 & 9774	endoribonuclease L-PSP, putative
ORF04888	9775 & 9776	aspartate carbamoyltransferase, regulatory subunit (pyrI)
ORF04889	9777 & 9778	aspartate carbamoyltransferase (pyrB) [2.1.3.2]
ORF04890	9779 & 9780	arginine repressor
ORF04891	9781 & 9782	membrane protein, putative
ORF04892	9783 & 9784	ornithine carbamoyltransferase (argF) [2.1.3.3]
ORF04893	9785 & 9786	carbamate kinase (arcC) [2.7.2.2]
ORF04894	9787 & 9788	arginine deiminase (arcA) [3.5.3.6]
ORF04895	9789 & 9790	Protein yjgK
ORF04896	9791 & 9792	ornithine carbamoyltransferase (argF) [2.1.3.3]
ORF04897	9793 & 9794	Protein
ORF04898	9795 & 9796	hypothetical protein
ORF04899	9797 & 9798	acetyltransferase, GNAT family family
ORF04900	9799 & 9800	probable innner membrane protein STY4813
ORF04901	9801 & 9802	valyl-tRNA synthetase (valS) [6.1.1.9]
ORF04902	9803 & 9804	DNA polymerase III, chi subunit [2.7.7.7]
ORF04903	9805 & 9806	Cytosol aminopeptidase (Leucine aminopeptidase) (LAP)(Leucyl aminopeptidase) (Aminopeptidase A-I) (LAP) [3.4.11.1]
ORF04904	9807 & 9808	conserved hypothetical protein
ORF04905	9809 & 9810	unnamed protein product
ORF04906	9811 & 9812	hypothetical protein
ORF04907	9813 & 9814	predicted permease
ORF04908	9815 & 9816	conserved ATP-binding protein
ORF04909	9817 & 9818	L-idonate Regulatory protein (gnt)
ORF04910	9819 & 9820	Gnt-II system L-idonate transporter
ORF04911	9821 & 9822	PROBABLE GLUCONATE 5-DEHYDROGENASE OXIDOREDUCTASE PROTEIN [1.1.1.69]
ORF04912	9823 & 9824	2,3-butanediol dehydrogenase [1.1.1.264]
ORF04913	9825 & 9826	thermoresistant gluconokinase [2.7.1.12]

ORF04914	9827 & 9828	NADP-dependent alcohol dehydrogenase [1.1.1.-]
ORF04915	9829 & 9830	Integrase
ORF04916	9831 & 9832	CII protein
ORF04917	9833 & 9834	Beta protein
ORF04918	9835 & 9836	Polarity suppression protein (Amber mutation-suppressing protein)
ORF04919	9837 & 9838	Transactivation protein
ORF04920	9839 & 9840	Glycoprotein 3 (Capsid size determination protein)
ORF04921	9841 & 9842	phage DNA binding protein
ORF04922	9843 & 9844	unnamed protein product; cI gene product (AA 1-137)
ORF04923	9845 & 9846	conserved hypothetical protein
ORF04924	9847 & 9848	conserved hypothetical protein
ORF04925	9849 & 9850	Bacteriophage P4 DNA primase [2.7.7.-]
ORF04926	9851 & 9852	hypothetical protein
ORF04927	9853 & 9854	hypothetical protein
ORF04928	9855 & 9856	ATP-dependent protease La
ORF04929	9857 & 9858	conserved hypothetical protein
ORF04930	9859 & 9860	conserved hypothetical protein
ORF04931	9861 & 9862	unnamed protein product; ORF616
ORF04932	9863 & 9864	Kelch motif domain protein
ORF04933	9865 & 9866	Oligogalacturonate-specific porin protein (KdgM) superfamily
ORF04934	9867 & 9868	FimB protein
ORF04935	9869 & 9870	recombinase involved in phase variation regulator for
ORF04936	9871 & 9872	type 1 fimbrial protein fimA precursor
ORF04937	9873 & 9874	fimbrial protein
ORF04938	9875 & 9876	Chaperone protein fimC precursor
ORF04939	9877 & 9878	Outer membrane usher protein fimD precursor
ORF04940	9879 & 9880	FimF protein precursor
ORF04941	9881 & 9882	fimbrial morphology
ORF04942	9883 & 9884	FimH
ORF04943	9885 & 9886	mannonate dehydratase (uxuA) [4.2.1.8]
ORF04944	9887 & 9888	D-mannonate oxidoreductase [1.1.1.57]
ORF04945	9889 & 9890	regulator of uxu operon
ORF04946	9891 & 9892	Protein of unknown function (DUF1316) subfamily
ORF04947	9893 & 9894	phosphoenolpyruvate-protein phosphotransferase,EI-HPr-EIIA components
ORF04948	9895 & 9896	dihydroxyacetone kinase, L subunit [2.7.1.-]
ORF04949	9897 & 9898	dihydroxyacetone kinase, DhaK subunit (dhaK) [2.7.1.-]
ORF04950	9899 & 9900	hypothetical protein
ORF04951	9901 & 9902	glycerol dehydrogenase CgrD (NAD) [1.1.1.6]
ORF04952	9903 & 9904	putative transporter CgxT
ORF04953	9905 & 9906	invasion protein IbeA
ORF04954	9907 & 9908	choline-glycine betaine transporter
ORF04955	9909 & 9910	Glycerate kinase [2.7.1.31]
ORF04956	9911 & 9912	2-hydroxy-3-oxopropionate reductase [1.1.1.60]
ORF04957	9913 & 9914	hydroxypyruvate isomerase [5.3.1.22]
ORF04958	9915 & 9916	hypothetical protein
ORF04959	9917 & 9918	glyoxylate carboligase [4.1.1.47]
ORF04960	9919 & 9920	glyoxylate carboligase [4.1.1.47]
ORF04961	9921 & 9922	NtrC family Transcriptional regulator, ATPase domain
ORF04962	9923 & 9924	invasion protein IbeA
ORF04963	9925 & 9926	hypothetical protein
ORF04964	9927 & 9928	Na+-H+ antiporter NhaC (nhaC)
ORF04965	9929 & 9930	Hypothetical transcriptional regulator yjiE

ORF04966	9931 & 9932	hypothetical protein
ORF04967	9933 & 9934	isoaspartyl dipeptidase (iadA) [3.4.19.-]
ORF04968	9935 & 9936	uncharacterized membrane protein
ORF04969	9937 & 9938	Nucleoside recognition domain protein
ORF04970	9939 & 9940	RNA 2'-phosphotransferase, Tpt1 - KptA family domain protein
ORF04971	9941 & 9942	conserved hypothetical protein
ORF04972	9943 & 9944	membrane protein, putative
ORF04973	9945 & 9946	SrgB
ORF04974	9947 & 9948	conserved hypothetical protein
ORF04975	9949 & 9950	Activator of 2-hydroxyglutaryl-CoA dehydratase (HSP70-class ATPase domain)
ORF04976	9951 & 9952	2-hydroxyglutaryl-CoA dehydratase subunit beta homolog
ORF04977	9953 & 9954	Protein of unknown function (DUF445) superfamily
ORF04978	9955 & 9956	transposase
ORF04979	9957 & 9958	conserved protein
ORF04980	9959 & 9960	conserved hypothetical protein
ORF04981	9961 & 9962	Type I restriction enzyme EcoKI specificity protein (S protein)(S.EcoKI) [3.1.21.3]
ORF04982	9963 & 9964	Type I restriction enzyme EcoKI M protein (M.EcoKI) [2.1.1.72]
ORF04983	9965 & 9966	Type I restriction enzyme EcoKI R protein (R.EcoKI) [3.1.21.3]
ORF04984	9967 & 9968	Mrr restriction system protein (EcoKMrr)
ORF04985	9969 & 9970	CobW-P47K family protein domain protein
ORF04986	9971 & 9972	Uncharacterized small protein
ORF04987	9973 & 9974	YjiY
ORF04988	9975 & 9976	Methyl-accepting chemotaxis protein I (MCP-I) (Serine chemoreceptorprotein) (MCP-I)
ORF04989	9977 & 9978	C4-dicarboxylate transporter large subunit (DctM)
ORF04990	9979 & 9980	TRAP transporter, DctQ-like membrane protein superfamily
ORF04991	9981 & 9982	DctP protein
ORF04992	9983 & 9984	Na+-H+ antiporter
ORF04993	9985 & 9986	yjjM gene product
ORF04994	9987 & 9988	sorbitol dehydrogenase, putative [1.1.1.14]
ORF04995	9989 & 9990	hypothetical protein

TABLE 2—142 preferred antigens

ORF00010	ORF00017	ORF00029	ORF00041	ORF00130
ORF00250	ORF00251	ORF00252	ORF00332	ORF00333
ORF00342	ORF00353	ORF00394	ORF00405	ORF00469
ORF00631	ORF00773	ORF00905	ORF00908	ORF01034
ORF01037	ORF01056	ORF01090	ORF01103	ORF01104
ORF01108	ORF01115	ORF01118	ORF01119	ORF01194
ORF01202	ORF01207	ORF01208	ORF01214	ORF01228
ORF01236	ORF01337	ORF01338	ORF01339	ORF01340
ORF01341	ORF01342	ORF01344	ORF01348	ORF01349
ORF01350	ORF01351	ORF01365	ORF01371	ORF01462
ORF01477	ORF01491	ORF01503	ORF01506	ORF01589
ORF01590	ORF01592	ORF01656	ORF01660	ORF01705
ORF01722	ORF01723	ORF01855	ORF01932	ORF02307
ORF02314	ORF02392	ORF02412	ORF02424	ORF02470
ORF02554	ORF02735	ORF02816	ORF02828	ORF02829
ORF02830	ORF02831	ORF02832	ORF02833	ORF02834
ORF02847	ORF02866	ORF02868	ORF02878	ORF02888
ORF03011	ORF03020	ORF03021	ORF03025	ORF03044
ORF03166	ORF03174	ORF03176	ORF03235	ORF03252
ORF03262	ORF03300	ORF03348	ORF03349	ORF03364
ORF03459	ORF03501	ORF03504	ORF03507	ORF03512
ORF03515	ORF03516	ORF03517	ORF03518	ORF03519
ORF03520	ORF03522	ORF03535	ORF03539	ORF03540
ORF03541	ORF03542	ORF03575	ORF03576	ORF03579
ORF03580	ORF03613	ORF04162	ORF04163	ORF04184
ORF04203	ORF04204	ORF04282	ORF04390	ORF04391
ORF04402	ORF04477	ORF04608	ORF04693	ORF04694
ORF04844	ORF04845	ORF04849	ORF04851	ORF04922
ORF04924	ORF04925			

Cytoplasmic location: *ORF00252, ORF01056, ORF01337, ORF01341, ORF01344, ORF01348, ORF01371, ORF01477, ORF02424, ORF02833, ORF03348, ORF03504, ORF03542, ORF04162, ORF04844.*

Inner membrane location: *ORF00010, ORF00017, ORF00029, ORF00041, ORF00130, ORF00332, ORF00333, ORF00342, ORF00353, ORF00394, ORF00405, ORF00631, ORF00773, ORF00905, ORF01034, ORF01037, ORF01090, ORF01103, ORF01104, ORF01108, ORF01115, ORF01118, ORF01119, ORF01194, ORF01202, ORF01207, ORF01208, ORF01214, ORF01338, ORF01339, ORF01349, ORF01350, ORF01365, ORF01462, ORF01491, ORF01503, ORF01506, ORF01590, ORF01705, ORF01722, ORF01723, ORF01855, ORF01932, ORF02314, ORF02392, ORF02412, ORF02470, ORF02554, ORF02735, ORF02847, ORF02868, ORF02878, ORF02888, ORF03020, ORF03021, ORF03025, ORF03044, ORF03174, ORF03176, ORF03235, ORF03300, ORF03349, ORF03364, ORF03459, ORF03501, ORF03507, ORF03512, ORF03519, ORF03520, ORF03535, ORF03539, ORF03540, ORF03575, ORF03576, ORF03579, ORF03580, ORF04163, ORF04184, ORF04203, ORF04204, ORF04402, ORF04477, ORF04608, ORF04693, ORF04694, ORF04845, ORF04849, ORF04851, ORF04922, ORF04924, ORF04925.*

Outer membrane location: *ORF00250, ORF00251, ORF00469, ORF01228, ORF01236, ORF01340, ORF01342, ORF01351, ORF01592, ORF01656, ORF02829, ORF02831, ORF02834, ORF03166, ORF03517, ORF03613, ORF04282.*

Periplasmic location: *ORF00908, ORF01589, ORF01660, ORF02307, ORF02816, ORF02828, ORF02830, ORF02832, ORF02866, ORF03011, ORF03252, ORF03262, ORF03515, ORF03516, ORF03518, ORF03522, ORF03541, ORF04390, ORF04391*

TABLE 3—low homology with commensal strains

ORF00010, ORF00016, ORF00017, ORF00018, ORF00019, ORF00020, ORF00025, ORF00028, ORF00029, ORF00030, ORF00031, ORF00032, ORF00034, ORF00035, ORF00036, ORF00037, ORF00041, ORF00042, ORF00043, ORF00044, ORF00045, ORF00046, ORF00047, ORF00048, ORF00049, ORF00050, ORF00051, ORF00052, ORF00053, ORF00054, ORF00055, ORF00056, ORF00057, ORF00058, ORF00059, ORF00060, ORF00061, ORF00062, ORF00064, ORF00065, ORF00066, ORF00067, ORF00068, ORF00069, ORF00070, ORF00089, ORF00090, ORF00106, ORF00107, ORF00119, ORF00120, ORF00121, ORF00130, ORF00134, ORF00150, ORF00151, ORF00152, ORF00163, ORF00169, ORF00198, ORF00222, ORF00223, ORF00224, ORF00225, ORF00226, ORF00231, ORF00232, ORF00233, ORF00250, ORF00251, ORF00252, ORF00253, ORF00254, ORF00255, ORF00256, ORF00257, ORF00330, ORF00331, ORF00332, ORF00333, ORF00334, ORF00335, ORF00336, ORF00337, ORF00338, ORF00339, ORF00340, ORF00341, ORF00342, ORF00343, ORF00344, ORF00345, ORF00346, ORF00347, ORF00348, ORF00349, ORF00350, ORF00351, ORF00352, ORF00353, ORF00361, ORF00379, ORF00380, ORF00381, ORF00382, ORF00383, ORF00394, ORF00395, ORF00396, ORF00397, ORF00399, ORF00400, ORF00401, ORF00402, ORF00403, ORF00404, ORF00407, ORF00415, ORF00416, ORF00417, ORF00418, ORF00419, ORF00433, ORF00434, ORF00435, ORF00436, ORF00437, ORF00442, ORF00444, ORF00455, ORF00587, ORF00588, ORF00591, ORF00597, ORF00598, ORF00599, ORF00600, ORF00631, ORF00644, ORF00646, ORF00647, ORF00648, ORF00649, ORF00650, ORF00655, ORF00656, ORF00657, ORF00659, ORF00660, ORF00661, ORF00662, ORF00663, ORF00664, ORF00665, ORF00666, ORF00667, ORF00668, ORF00669, ORF00670, ORF00671, ORF00672, ORF00673, ORF00674, ORF00675, ORF00676, ORF00677, ORF00678, ORF00680, ORF00681, ORF00682, ORF00683, ORF00685, ORF00687, ORF00773, ORF00786, ORF00787, ORF00788, ORF00789, ORF00790, ORF00791, ORF00792, ORF00793, ORF00794, ORF00795, ORF00796, ORF00798, ORF00803, ORF00804, ORF00809, ORF00810, ORF00838, ORF00839, ORF00857, ORF00864, ORF00883, ORF00884, ORF00885, ORF00886, ORF00887, ORF00888, ORF00889, ORF00890, ORF00891, ORF00892, ORF00893, ORF00894, ORF00895, ORF00896, ORF00897, ORF00898, ORF00899, ORF00900, ORF00901, ORF00902, ORF00903, ORF00904, ORF00905, ORF00906, ORF00907, ORF00908, ORF00909, ORF00910, ORF00924, ORF00925, ORF00926, ORF00948, ORF00956, ORF01031, ORF01032, ORF01033, ORF01034, ORF01035, ORF01036, ORF01037, ORF01038, ORF01039, ORF01040, ORF01041, ORF01042, ORF01043, ORF01044, ORF01045, ORF01046, ORF01047, ORF01048, ORF01052, ORF01053, ORF01054, ORF01055, ORF01056, ORF01057, ORF01058, ORF01063, ORF01078, ORF01079, ORF01080, ORF01081, ORF01084, ORF01085, ORF01086, ORF01087, ORF01088, ORF01089, ORF01090, ORF01091, ORF01092, ORF01093, ORF01094, ORF01095, ORF01096, ORF01097, ORF01098, ORF01099, ORF01100, ORF01101, ORF01102, ORF01103, ORF01104, ORF01105, ORF01106, ORF01107, ORF01108, ORF01109, ORF01110, ORF01111, ORF01112, ORF01113, ORF01114, ORF01115, ORF01116, ORF01117, ORF01118, ORF01119, ORF01156, ORF01186, ORF01187, ORF01188, ORF01190, ORF01191, ORF01192, ORF01193, ORF01194, ORF01195, ORF01196, ORF01199, ORF01200, ORF01201, ORF01202, ORF01203, ORF01204, ORF01205, ORF01206, ORF01207, ORF01208, ORF01209,

ORF01210, ORF01211, ORF01212, ORF01213, ORF01214, ORF01215, ORF01216, ORF01217, ORF01218, ORF01219, ORF01220, ORF01222, ORF01223, ORF01224, ORF01225, ORF01226, ORF01227, ORF01228, ORF01236, ORF01252, ORF01253, ORF01254, ORF01255, ORF01256, ORF01257, ORF01258, ORF01259, ORF01260, ORF01261, ORF01283, ORF01313, ORF01314, ORF01315, ORF01316, ORF01317, ORF01318, ORF01319, ORF01320, ORF01321, ORF01322, ORF01323, ORF01325, ORF01330, ORF01331, ORF01332, ORF01333, ORF01334, ORF01335, ORF01336, ORF01337, ORF01338, ORF01339, ORF01340, ORF01341, ORF01342, ORF01343, ORF01344, ORF01345, ORF01346, ORF01347, ORF01348, ORF01349, ORF01350, ORF01351, ORF01352, ORF01353, ORF01354, ORF01355, ORF01356, ORF01357, ORF01359, ORF01360, ORF01361, ORF01365, ORF01366, ORF01367, ORF01368, ORF01371, ORF01373, ORF01374, ORF01375, ORF01376, ORF01394, ORF01456, ORF01462, ORF01477, ORF01479, ORF01480, ORF01483, ORF01484, ORF01485, ORF01486, ORF01487, ORF01488, ORF01490, ORF01491, ORF01492, ORF01493, ORF01494, ORF01498, ORF01499, ORF01500, ORF01501, ORF01502, ORF01503, ORF01504, ORF01505, ORF01506, ORF01507, ORF01508, ORF01509, ORF01510, ORF01511, ORF01512, ORF01513, ORF01514, ORF01518, ORF01523, ORF01524, ORF01525, ORF01526, ORF01527, ORF01528, ORF01529, ORF01530, ORF01531, ORF01532, ORF01533, ORF01534, ORF01535, ORF01536, ORF01537, ORF01538, ORF01539, ORF01540, ORF01541, ORF01542, ORF01543, ORF01550, ORF01551, ORF01552, ORF01553, ORF01554, ORF01555, ORF01556, ORF01557, ORF01558, ORF01559, ORF01560, ORF01561, ORF01562, ORF01563, ORF01564, ORF01565, ORF01566, ORF01567, ORF01568, ORF01569, ORF01570, ORF01571, ORF01572, ORF01573, ORF01574, ORF01575, ORF01576, ORF01577, ORF01578, ORF01583, ORF01588, ORF01589, ORF01590, ORF01591, ORF01592, ORF01593, ORF01609, ORF01610, ORF01611, ORF01612, ORF01613, ORF01630, ORF01631, ORF01637, ORF01651, ORF01655, ORF01656, ORF01657, ORF01658, ORF01659, ORF01660, ORF01665, ORF01705, ORF01722, ORF01723, ORF01724, ORF01725, ORF01766, ORF01767, ORF01768, ORF01769, ORF01770, ORF01790, ORF01810, ORF01812, ORF01813, ORF01815, ORF01816, ORF01817, ORF01818, ORF01819, ORF01820, ORF01821, ORF01822, ORF01823, ORF01824, ORF01825, ORF01826, ORF01827, ORF01828, ORF01829, ORF01830, ORF01831, ORF01832, ORF01833, ORF01834, ORF01835, ORF01836, ORF01837, ORF01838, ORF01840, ORF01842, ORF01843, ORF01844, ORF01845, ORF01846, ORF01847, ORF01848, ORF01849, ORF01850, ORF01852, ORF01853, ORF01854, ORF01855, ORF01856, ORF01857, ORF01861, ORF01862, ORF01865, ORF01891, ORF01923, ORF01926, ORF01927, ORF01928, ORF01929, ORF01930, ORF01931, ORF01932, ORF01946, ORF01953, ORF01955, ORF01956, ORF01987, ORF02112, ORF02266, ORF02289, ORF02295, ORF02296, ORF02297, ORF02298, ORF02299, ORF02300, ORF02301, ORF02302, ORF02303, ORF02304, ORF02305, ORF02306, ORF02307, ORF02308, ORF02309, ORF02310, ORF02311, ORF02312, ORF02313, ORF02314, ORF02315, ORF02327, ORF02338, ORF02351, ORF02352, ORF02353, ORF02354, ORF02355, ORF02356, ORF02358, ORF02359, ORF02361, ORF02362, ORF02363, ORF02364, ORF02365, ORF02366, ORF02367, ORF02368, ORF02369, ORF02370, ORF02371, ORF02372, ORF02373, ORF02374, ORF02375, ORF02382, ORF02383, ORF02384, ORF02385, ORF02386, ORF02387, ORF02388, ORF02389, ORF02390, ORF02392, ORF02393, ORF02394, ORF02395, ORF02396,

ORF02397, ORF02398, ORF02399, ORF02400, ORF02401, ORF02402, ORF02403, ORF02404, ORF02405, ORF02413, ORF02414, ORF02415, ORF02419, ORF02420, ORF02421, ORF02422, ORF02423, ORF02424, ORF02425, ORF02429, ORF02432, ORF02436, ORF02437, ORF02438, ORF02439, ORF02440, ORF02441, ORF02442, ORF02443, ORF02444, ORF02445, ORF02446, ORF02447, ORF02448, ORF02449, ORF02450, ORF02451, ORF02452, ORF02453, ORF02454, ORF02455, ORF02456, ORF02457, ORF02458, ORF02459, ORF02460, ORF02461, ORF02462, ORF02464, ORF02465, ORF02466, ORF02467, ORF02468, ORF02469, ORF02470, ORF02471, ORF02472, ORF02501, ORF02502, ORF02503, ORF02504, ORF02505, ORF02506, ORF02507, ORF02533, ORF02534, ORF02552, ORF02553, ORF02554, ORF02555, ORF02582, ORF02583, ORF02595, ORF02614, ORF02628, ORF02633, ORF02699, ORF02735, ORF02788, ORF02789, ORF02790, ORF02791, ORF02792, ORF02793, ORF02794, ORF02795, ORF02796, ORF02797, ORF02798, ORF02799, ORF02800, ORF02801, ORF02802, ORF02803, ORF02804, ORF02805, ORF02806, ORF02807, ORF02808, ORF02809, ORF02810, ORF02811, ORF02812, ORF02813, ORF02814, ORF02815, ORF02816, ORF02828, ORF02829, ORF02830, ORF02831, ORF02832, ORF02833, ORF02834, ORF02835, ORF02844, ORF02845, ORF02846, ORF02847, ORF02848, ORF02849, ORF02850, ORF02851, ORF02852, ORF02853, ORF02854, ORF02855, ORF02856, ORF02857, ORF02858, ORF02859, ORF02860, ORF02861, ORF02862, ORF02863, ORF02864, ORF02865, ORF02866, ORF02867, ORF02868, ORF02869, ORF02870, ORF02871, ORF02872, ORF02873, ORF02874, ORF02875, ORF02876, ORF02877, ORF02878, ORF02879, ORF02880, ORF02881, ORF02882, ORF02883, ORF02884, ORF02885, ORF02886, ORF02887, ORF02888, ORF02889, ORF02890, ORF02891, ORF02931, ORF03011, ORF03012, ORF03013, ORF03014, ORF03015, ORF03016, ORF03017, ORF03018, ORF03019, ORF03020, ORF03021, ORF03022, ORF03023, ORF03024, ORF03025, ORF03026, ORF03027, ORF03028, ORF03029, ORF03030, ORF03031, ORF03032, ORF03033, ORF03034, ORF03035, ORF03036, ORF03037, ORF03038, ORF03039, ORF03040, ORF03041, ORF03042, ORF03043, ORF03044, ORF03045, ORF03046, ORF03047, ORF03048, ORF03049, ORF03053, ORF03054, ORF03055, ORF03056, ORF03114, ORF03130, ORF03131, ORF03132, ORF03133, ORF03162, ORF03163, ORF03164, ORF03165, ORF03166, ORF03167, ORF03173, ORF03174, ORF03175, ORF03176, ORF03191, ORF03192, ORF03206, ORF03207, ORF03235, ORF03236, ORF03252, ORF03262, ORF03263, ORF03279, ORF03296, ORF03297, ORF03298, ORF03299, ORF03300, ORF03325, ORF03340, ORF03341, ORF03342, ORF03343, ORF03344, ORF03345, ORF03346, ORF03347, ORF03348, ORF03349, ORF03350, ORF03351, ORF03352, ORF03353, ORF03354, ORF03355, ORF03356, ORF03357, ORF03358, ORF03359, ORF03360, ORF03361, ORF03362, ORF03363, ORF03364, ORF03365, ORF03400, ORF03415, ORF03453, ORF03454, ORF03455, ORF03456, ORF03457, ORF03458, ORF03459, ORF03465, ORF03469, ORF03499, ORF03500, ORF03501, ORF03502, ORF03503, ORF03504, ORF03505, ORF03506, ORF03507, ORF03508, ORF03509, ORF03510, ORF03511, ORF03512, ORF03515, ORF03516, ORF03517, ORF03518, ORF03519, ORF03520, ORF03521, ORF03522, ORF03526, ORF03535, ORF03536, ORF03537, ORF03538, ORF03539, ORF03540, ORF03541, ORF03542, ORF03574, ORF03575, ORF03576, ORF03577, ORF03578, ORF03579, ORF03580, ORF03589, ORF03592, ORF03593, ORF03594, ORF03595, ORF03596, ORF03597, ORF03606, ORF03607, ORF03608, ORF03610,

ORF03612, ORF03613, ORF03614, ORF03615, ORF03616, ORF03617, ORF03619, ORF03695, ORF03696, ORF03817, ORF03818, ORF03819, ORF03820, ORF03821, ORF03822, ORF03823, ORF03824, ORF03825, ORF03826, ORF03975, ORF03991, ORF03992, ORF03993, ORF03994, ORF03995, ORF03996, ORF03997, ORF03998, ORF03999, ORF04000, ORF04031, ORF04032, ORF04033, ORF04034, ORF04035, ORF04036, ORF04058, ORF04059, ORF04060, ORF04061, ORF04062, ORF04063, ORF04064, ORF04073, ORF04083, ORF04084, ORF04085, ORF04086, ORF04087, ORF04088, ORF04089, ORF04090, ORF04091, ORF04130, ORF04162, ORF04163, ORF04164, ORF04171, ORF04183, ORF04184, ORF04203, ORF04204, ORF04205, ORF04206, ORF04207, ORF04208, ORF04209, ORF04211, ORF04224, ORF04225, ORF04237, ORF04238, ORF04239, ORF04240, ORF04241, ORF04242, ORF04243, ORF04244, ORF04247, ORF04250, ORF04282, ORF04302, ORF04390, ORF04391, ORF04398, ORF04402, ORF04403, ORF04404, ORF04416, ORF04417, ORF04418, ORF04419, ORF04420, ORF04421, ORF04422, ORF04423, ORF04424, ORF04425, ORF04426, ORF04427, ORF04428, ORF04429, ORF04430, ORF04434, ORF04435, ORF04436, ORF04437, ORF04438, ORF04439, ORF04451, ORF04476, ORF04477, ORF04478, ORF04479, ORF04480, ORF04481, ORF04482, ORF04483, ORF04484, ORF04489, ORF04490, ORF04500, ORF04542, ORF04543, ORF04544, ORF04545, ORF04546, ORF04547, ORF04552, ORF04569, ORF04572, ORF04573, ORF04608, ORF04612, ORF04623, ORF04626, ORF04627, ORF04628, ORF04629, ORF04630, ORF04631, ORF04632, ORF04661, ORF04662, ORF04663, ORF04664, ORF04665, ORF04668, ORF04669, ORF04671, ORF04672, ORF04673, ORF04674, ORF04675, ORF04676, ORF04677, ORF04678, ORF04679, ORF04691, ORF04692, ORF04693, ORF04694, ORF04708, ORF04709, ORF04710, ORF04711, ORF04712, ORF04728, ORF04844, ORF04845, ORF04846, ORF04847, ORF04848, ORF04849, ORF04850, ORF04851, ORF04882, ORF04890, ORF04891, ORF04892, ORF04893, ORF04894, ORF04895, ORF04898, ORF04900, ORF04915, ORF04916, ORF04917, ORF04918, ORF04919, ORF04920, ORF04921, ORF04922, ORF04923, ORF04924, ORF04925, ORF04926, ORF04927, ORF04928, ORF04929, ORF04930, ORF04946, ORF04947, ORF04948, ORF04949, ORF04950, ORF04951, ORF04952, ORF04953, ORF04954, ORF04955, ORF04956, ORF04957, ORF04958, ORF04959, ORF04960, ORF04961, ORF04962, ORF04963, ORF04964, ORF04966, ORF04974, ORF04978, ORF04979, ORF04981, ORF04989, ORF04990, ORF04991, ORF04992, ORF04993, ORF04995

PCT/US06/05913

TABLE 4

Protein	SEQ ID	Annotation	Psort	TMD	CFT073	%ID
ORF03526	7051 + 7052	Accessory colonization factor AcfD precursor	I	0	upec-2704	45.3
ORF01339	2677 + 2678	F1C fimbrial usher	I	1	upec-1199	99.4
ORF00256	511+512	pilin chaperone ecpD2	I	1	upec-0166	100
ORF01346	2691 + 2692	IroN protein	O	0	upec-1207	99.3
ORF04084	8167 + 8168	outer membrane hemin receptor ChuA	O	0	upec-4213	99.7
ORF02374	4747 + 4748	OMR family pesticin-yersiniabactin receptor protein (IRPC)	O	0	upec-2371	100
ORF03502	7003 + 7004	polysaccharide biosynthesis protein, putative	O	0	upec-3606	99.5
ORF02298	4595 + 4596	hypothetical protein	C	0	upec-5009	30
ORF01228	2455 + 2456	CdtC	O	0	upec-1086	30.3
ORF01227	2453 + 2454	CdtB	I	1	upec-0679	31.9
ORF02314	4627 + 4628	gpH	I	1	upec-0941	48.8
ORF02850	5699 + 5700	DNA transfer protein	C	0	upec-4881	21.2

Columns:

- **PSORT**: predicted location by the PSORT algorithm. I = inner membrane; O = outer membrane; P = periplasm; C = cytoplasm
- TMD: number of transmembrane domains
- %ID: percentage identitical residues over length of alignment

REFERENCES (the contents of which are hereby incorporated by reference)

[1] Russo & Johnson (2000) *J Infect Dis* 181:1753-1754.

[2] Uehling *et al.* (1997) *J Urol* 157:2049-2052.

[3] Tammen (1990) *Br J Urol* 65:6-9.

[4] Langermann *et al.* (1997) *Science* 276:607-611.

[5] WO03/074553.

[6] WO01/66572.

[7] Janke *et al.* (2001) *FEMS Microbiol Lett* 199:61-66.

[8] WO2004/005535.

[9] Dobrindt *et al.* (2002) *Infect Immun* 70:6365-6372.

[10] US2003/0165870.

[11] Welch *et al.* (2002) *Proc Natl Acad Sci USA* 99:17020-17024.

[12] American Type Culture Collection: ATCC 700928.

[13] *European Journal of Biochemistry* 2003; 1 Supplement 1 July: abstract P1.3-11.

[14] Geysen *et al.* (1984) *PNAS USA* 81:3998-4002.

[15] Carter (1994) *Methods Mol Biol* 36:207-223.

[16] Jameson, BA *et al.* 1988, *CABIOS* 4(1):181-186.

[17] Raddrizzani & Hammer (2000) *Brief Bioinform* 1(2):179-189.

TABLES OMITTED

[18] De Lalla *et al.* (1999) *J. Immunol.* 163:1725-1729.

[19] Brusic *et al.* (1998) *Bioinformatics* 14(2):121-130

[20] Meister *et al.* (1995) *Vaccine* 13(6):581-591.

[21] Roberts *et al.* (1996) *AIDS Res Hum Retroviruses* 12(7):593-610.

[22] Maksyutov & Zagrebelnaya (1993) *Comput Appl Biosci* 9(3):291-297.

[23] Feller & de la Cruz (1991) *Nature* 349(6311):720-1.

[24] Hopp (1993) *Peptide Research* 6:183-190.

[25] Welling *et al.* (1985) *FEBS Lett.* 188:215-218.

[26] Davenport *et al.* (1995) *Immunogenetics* 42:392-297.

[27] Bodanszky (1993) *Principles of Peptide Synthesis* (ISBN: 0387564314).

[28] Fields *et al.* (1997) *Meth Enzymol* 289: *Solid-Phase Peptide Synthesis.* ISBN: 0121821900.

[29] Chan & White (2000) *Fmoc Solid Phase Peptide Synthesis.* ISBN: 0199637245.

[30] Kullmann (1987) *Enzymatic Peptide Synthesis.* ISBN: 0849368413.

[31] Ibba (1996) *Biotechnol Genet Eng Rev* 13:197-216.

[32] Breedveld (2000) *Lancet* 355(9205):735-740.

[33] Gorman & Clark (1990) *Semin. Immunol.* 2:457-466.

[34] Sambrook *et al.* (2001) *Molecular Cloning: A Laboratory Manual*, 3rd edition (Cold Spring Harbor Laboratory Press).

[35] Ausubel *et al.* (eds) (2002) *Short protocols in molecular biology*, 5th edition (Current Protocols).

[36] US patent 5,707,829

[37] *Current Protocols in Molecular Biology* (F.M. Ausubel *et al.* eds., 1987) Supplement 30.

[38] EP-B-0509612.

[39] EP-B-0505012.

[40] Johnson & Stell (2001) *J Clin Microbiol* 39:3712-33717.

[41] Tang *et al.* (1997) *Clin. Chem.* 43:2021-2038.

[42] PCT/IB2005/003494.

[43] Bernadac *et al.* (1998) *J Bacteriol* 180(18):4872-4878.

[44] EP-1441036.

[45] Sorensen & Mortensen (2005) *Journal of Biotechnology* 115:113–128.

[46] Meynial-Salles *et al.* (2005) *Applied and Environmental Microbiology* 71:2140–2144.

[47] US2004/0209370.

[48] WO00/68253.

[49] WO97/04110.

[50] Alper *et al.* (2005) *Proc. Natl. Acad. Sci. USA* 102:12678–12683.

[51] WO 01/09350.

[52] European patent 0624376.

[53] *Vaccine Design...* (1995) eds. Powell & Newman. ISBN: 030644867X. Plenum.

[54] WO00/23105.

[55] WO90/14837.

FURTHER DETAILS

[56] Podda (2001) *Vaccine* 19:2673-2680.

[57] Frey *et al.* (2003) *Vaccine* 21:4234-4237.

[58] *Vaccine Adjuvants: Preparation Methods and Research Protocols* (Volume 42 of *Methods in Molecular Medicine* series). ISBN: 1-59259-083-7. Ed. O'Hagan.

[59] US Patent 6,299,884.

[60] US Patent 6,451,325.

[61] Allison & Byars (1992) *Res Immunol* 143:519-525.

[62] Hariharan *et al.* (1995) *Cancer Res* 55:3486-3489.

[63] US patent 5,057,540.

[64] WO96/33739.

[65] EP-A-0109942.

[66] WO96/11711.

[67] WO00/07621.

[68] Barr *et al.* (1998) *Advanced Drug Delivery Reviews* 32:247-271.

[69] Sjolanderet *et al.* (1998) *Advanced Drug Delivery Reviews* 32:321-338.

[70] Niikura *et al.* (2002) *Virology* 293:273-280.

[71] Lenz *et al.* (2001) *J Immunol* 166:5346-5355.

[72] Pinto *et al.* (2003) *J Infect Dis* 188:327-338.

[73] Gerber *et al.* (2001) *Virol* 75:4752-4760.

[74] WO03/024480

[75] WO03/024481

[76] Gluck *et al.* (2002) *Vaccine* 20:B10-B16.

[77] EP-A-0689454.

[78] Johnson *et al.* (1999) *Bioorg Med Chem Lett* 9:2273-2278.

[79] Evans *et al.* (2003) *Expert Rev Vaccines* 2:219-229.

[80] Meraldi *et al.* (2003) *Vaccine* 21:2485-2491.

[81] Pajak *et al.* (2003) *Vaccine* 21:836-842.

[82] Kandimalla *et al.* (2003) *Nucleic Acids Research* 31:2393-2400.

[83] WO02/26757.

[84] WO99/62923.

[85] Krieg (2003) *Nature Medicine* 9:831-835.

[86] McCluskie *et al.* (2002) *FEMS Immunology and Medical Microbiology* 32:179-185.

[87] WO98/40100.

[88] US patent 6,207,646.

[89] US patent 6,239,116.

[90] US patent 6,429,199.

[91] Kandimalla *et al.* (2003) *Biochemical Society Transactions* 31 (part 3):654-658.

[92] Blackwell *et al.* (2003) *J Immunol* 170:4061-4068.

[93] Krieg (2002) *Trends Immunol* 23:64-65.

[94] WO01/95935.

[95] Kandimalla *et al.* (2003) *BBRC* 306:948-953.

[96] Bhagat *et al.* (2003) *BBRC* 300:853-861.

[97] WO03/035836.

[98] WO95/17211.

[99] WO98/42375.

[100] Beignon *et al.* (2002) *Infect Immun* 70:3012-3019.

[101] Pizza *et al.* (2001) *Vaccine* 19:2534-2541.

[102] Pizza *et al.* (2000) *Int J Med Microbiol* 290:455-461.

[103] Scharton-Kersten *et al.* (2000) *Infect Immun* 68:5306-5313.

[104] Ryan *et al.* (1999) *Infect Immun* 67:6270-6280.

[105] Partidos *et al.* (1999) *Immunol Lett* 67:209-216.

[106] Peppoloni *et al.* (2003) *Expert Rev Vaccines* 2:285-293.

[107] Pine *et al.* (2002) *J Control Release* 85:263-270.

[108] Domenighini *et al.* (1995) *Mol Microbiol* 15:1165-1167.

[109] WO03/011223.

[110] WO99/40936.

[111] WO99/44636.

[112] Lillard JW *et al.*, (2003) *Blood* 101(3):807-14. Epub 2002 Sep 12.

[113] Singh *et al]* (2001) *J Cont Release* 70:267-276.

[114] WO99/27960.

[115] US patent 6,090,406

[116] US patent 5,916,588

[117] EP-A-0626169.

[118] WO99/52549.

[119] WO01/21207.

[120] WO01/21152.

[121] Andrianov *et al.* (1998) *Biomaterials* 19:109-115.

[122] Payne *et al.* (1998) *Adv Drug Delivery Review* 31:185-196.

[123] US 4,680,338.

[124] US 4,988,815.

[125] WO92/15582.

[126] Stanley (2002) *Clin Exp Dermatol* 27:571-577.

[127] Wu *et al.* (2004) *Antiviral Res.* 64(2):79-83.

[128] Vasilakos *et al.* (2000) *Cell Immunol.* 204(1):64-74.

[129] US patents 4689338, 4929624, 5238944, 5266575, 5268376, 5346905, 5352784, 5389640, 5395937, 5482936, 5494916, 5525612, 6083505, 6440992, 6627640, 6656938, 6660735, 6660747, 6664260, 6664264, 6664265, 6667312, 6670372, 6677347, 6677348, 6677349, 6683088, 6703402, 6743920, 6800624, 6809203, 6888000 and 6924293.

[130] Jones (2003) *Curr Opin Investig Drugs* 4:214-218.

[131] WO04/60308

[132] WO04/64759.
[133] US 6,924,271.
[134] US2005/0070556.
[135] US 5,658,731.
[136] Wong *et al.* (2003) *J Clin Pharmacol* 43(7):735-742.
[137] US2005/0215517.
[138] WO02/072012.
[139] Signorelli & Hadden (2003) *Int Immunopharmacol* 3(8):1177-1186.
[140] WO2004/064715.
[141] Cooper (1995) *Pharm Biotechnol* 6:559-580.
[142] PCT/US2005/022769.
[143] WO2004/87153.
[144] US 6,605,617.
[145] WO02/18383.
[146] WO2004/018455.
[147] WO03/082272.
[148] US patent 5,011,828.
[149] US-6586409.
[150] WO99/11241.
[151] WO94/00153.
[152] WO98/57659.
[153] European patent applications 0835318, 0735898 and 0761231.
[154] WO03/009869.
[155] Glezen & Alpers (1999) *Clin. Infect. Dis.* 28:219-224.
[156] Johnson *et al.* (2001) *Infect Immun* 69:1306-1314.
[157] Johnson *et al.* (2001) *J Infect Dis* 183:897-906 (see also 183:1546).
[158] Almeida & Alpar (1996) *J. Drug Targeting* 3:455-467.
[159] Agarwal & Mishra (1999) *Indian J Exp Biol* 37:6-16.
[160] Costantino *et al.* (1992) *Vaccine* 10:691-698.
[161] Costantino *et al.* (1999) *Vaccine* 17:1251-1263.
[162] International patent application WO03/007985.
[163] WO 99/24578.
[164] WO 99/36544.
[165] WO 99/57280.
[166] WO 00/66791.
[167] WO 01/64922.
[168] WO 01/64920.
[169] WO 03/020756.
[170] WO 2004/032958.
[171] WO 2004/048404.

[172] Watson (2000) *Pediatr Infect Dis J* 19:331-332.
[173] Rubin (2000) *Pediatr Clin North Am* 47:269-285, v.
[174] Jedrzejas (2001) *Microbiol Mol Biol Rev* 65:187-207.
[175] Bell (2000) *Pediatr Infect Dis J* 19:1187-1188.
[176] Iwarson (1995) *APMIS* 103:321-326.
[177] Gerlich *et al.* (1990) *Vaccine* 8 Suppl:S63-S68 & S79-S80.
[178] *Vaccines* (1988) eds. Plotkin & Mortimer. ISBN 0-7216-1946-0.
[179] Del Guidice *et al.* (1998) *Molecular Aspects of Medicine* 19:1-70.
[180] Hsu *et al.* (1999) *Clin Liver Dis* 3:901-915.
[181] Stratov *et al.* (2004) *Curr Drug Tgts* 5(1):71-88.
[182] Gustafsson *et al.* (1996) *N. Engl. J. Med.* 334:349-355.
[183] Rappuoli *et al.* (1991) *TIBTECH* 9:232-238.
[184] Sutter *et al.* (2000) *Pediatr Clin North Am* 47:287-308.
[185] Zimmerman & Spann (1999) *Am Fam Physician* 59:113-118, 125-126.
[186] McMichael (2000) *Vaccine* 19 Suppl 1:S101-S107.
[187] Schuchat (1999) *Lancet* 353(9146):51-56.
[188] International patent application WO02/34771.
[189] WO 99/24578.
[190] WO 99/36544.
[191] WO 99/57280.
[192] WO 02/079243.
[193] WO 02/02606.
[194] Kalman *et al.* (1999) *Nature Genetics* 21:385-389.
[195] Read *et al.* (2000) *Nucleic Acids Res* 28:1397-406.
[196] Shirai *et al.* (2000) *J. Infect. Dis.* 181(Suppl 3):S524-S527.
[197] WO 99/27105.
[198] WO 00/27994.
[199] WO 00/37494.
[200] WO2005/084306.
[201] WO2005/002619.
[202] Ross *et al.* (2001) *Vaccine* 19:4135-4142.
[203] Dreesen (1997) *Vaccine* 15 Suppl:S2-S6.
[204] *MMWR Morb Mortal Wkly Rep* 1998 Jan 16;47(1):12, 19.
[205] Anderson (2000) *Vaccine* 19 Suppl 1:S59-S65.
[206] Kahn (2000) *Curr Opin Pediatr* 12:257-262.
[207] Crowe (1995) *Vaccine* 13:415-421.
[208] Modlin *et al.* (2001) *J Toxicol Clin Toxicol* 39:85-100.
[209] Demicheli *et al.* (1998) *Vaccine* 16:880-884.
[210] Stepanov *et al.* (1996) *J Biotechnol* 44:155-160.
[211] Dale (1999) *Infect Dis Clin North Am* 13:227-243, viii.

TEXT USED / PRIOR ART

[212] Ferretti *et al.* (2001) *PNAS USA* 98: 4658-4663.

[213] Kuroda *et al.* (2001) *Lancet* 357(9264):1225-1240; see also pages 1218-1219.

[214] WO 00/09699.

[215] EP-A-0372501

[216] EP-A-0378881

[217] EP-A-0427347

[218] WO93/17712

[219] WO94/03208

[220] WO98/58668

[221] EP-A-0471177

[222] EP-A-0594610.

[223] WO00/56360

[224] WO91/01146

[225] WO00/61761

[226] WO01/72337

[227] Falugi *et al.* (2001) *Eur J Immunol* 31:3816-3824.

[228] Baraldo *et al*, (2004) *Infect Immun.*72:4884-4887

[229] WO02/091998.

[230] Kuo *et al.* (1995) *Infect Immun* 63:2706-2713.

[231] *Research Disclosure*, 453077 (Jan 2002)

[232] Donnelly *et al.* (1997) *Annu Rev Immunol* 15:617-648.

[233] Strugnell *et al.* (1997) *Immunol Cell Biol* 75(4):364-369.

[234] Cui (2005) *Adv Genet* 54:257-89.

[235] Robinson & Torres (1997) *Seminars in Immunol* 9:271-283.

[236] Brunham *et al.* (2000) *J Infect Dis* 181 Suppl 3:S538-S543.

[237] Svanholm *et al.* (2000) *Scand J Immunol* 51(4):345-353.

[238] *DNA Vaccination - Genetic Vaccination* (1998) eds. Koprowski *et al.* (ISBN 3540633928).

[239] *Gene Vaccination : Theory and Practice* (1998) ed. Raz (ISBN 3540644288).

[240] Findeis *et al.*, *Trends Biotechnol.* (1993) 11:202.

[241] Chiou *et al.* (1994) *Gene Therapeutics: Methods And Applications Of Direct Gene Transfer.* ed. Wolff.

[242] Wu *et al.*, *J. Biol. Chem.* (1988) *263*:621.

[243] Wu *et al.*, *J. Biol. Chem.* (1994) *269*:542.

[244] Zenke *et al.*, *Proc. Natl. Acad. Sci. (USA)* (1990) *87*:3655.

[245] Wu *et al.*, *J. Biol. Chem.* (1991) *266*:338.

[246] Jolly, *Cancer Gene Therapy* (1994) *1*:51.

[247] Kimura, *Human Gene Therapy* (1994) *5*:845.

[248] Connelly, *Human Gene Therapy* (1995) *1*:185.

[249] Kaplitt, *Nature Genetics* (1994) *6*:148.

[250] WO 90/07936.

[251] WO 94/03622.
[252] WO 93/25698.
[253] WO 93/25234.
[254] US 5,219,740.
[255] WO 93/11230.
[256] WO 93/10218.
[257] US 4,777,127.
[258] GB 2,200,651.
[259] EP-A-0 345 242.
[260] WO 91/02805.
[261] WO 94/12649.
[262] WO 93/03769.
[263] WO 93/19191.
[264] WO 94/28938.
[265] WO 95/11984.
[266] WO 95/00655.
[267] Curiel, *Hum. Gene Ther.* (1992) *3*:147.
[268] Wu, *J. Biol. Chem.* (1989) *264*:16985.
[269] US 5,814,482.
[270] WO 95/07994.
[271] WO 96/17072.
[272] WO 95/30763.
[273] WO 97/42338.
[274] WO 90/11092.
[275] US 5,580,859.
[276] US 5,422,120.
[277] WO 95/13796.
[278] WO 94/23697.
[279] WO 91/14445.
[280] EP 0524968.
[281] Philip, *Mol. Cell Biol.* (1994) *14*:2411.
[282] Woffendin, *Proc. Natl. Acad. Sci.* (1994) *91*:11581.
[283] US 5,206,152.
[284] WO 92/11033.
[285] US 5,149,655.
[286] WO 92/11033.
[287] Needleman& Wunsch (1970) *J. Mol. Biol.* 48:443-453.
[288] Rice *et al.* (2000) *Trends Genet* 16:276-277.
[289] Gennaro (2000) *Remington: The Science and Practice of Pharmacy.* 20th edition, ISBN: 0683306472.

[290] *Methods In Enzymology* (S. Colowick and N. Kaplan, eds., Academic Press, Inc.)

[291] *Handbook of Experimental Immunology*, Vols. I-IV (D.M. Weir and C.C. Blackwell, eds., 1986, Blackwell Scientific Publications)

[292] Sambrook *et al.* (2001) *Molecular Cloning: A Laboratory Manual*, 3rd edition (Cold Spring Harbor Laboratory Press).

[293] *Handbook of Surface and Colloidal Chemistry* (Birdi, K.S. ed., CRC Press, 1997)

[294] Ausubel *et al.* (eds) (2002) *Short protocols in molecular biology*, 5th edition (Current Protocols).

[295] *Molecular Biology Techniques: An Intensive Laboratory Course*, (Ream *et al.*, eds., 1998, Academic Press)

[296] *PCR (Introduction to Biotechniques Series)*, 2nd ed. (Newton & Graham eds., 1997, Springer Verlag)

[297] Dobrindt *et al.* (2003) *J Bacteriol* 185:1831-1840.

[298] Murphy (1998) *J. Bacteriol* 180:2063-2071.

[299] Huang *et al.* (2001) *J Infect Dis* 183:1071-1078.

[300] Russo *et al.* (2002) *Infect Immun* 70:7156-7160.

[301] Russo *et al.* (2002) *Infect Immun* 71:7164-7169.

PCT/US06/05913

CLAIMS

What is claimed:

1. A polypeptide comprising: (a) an amino acid sequence selected from the group consisting of SEQ ID NOs 706, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100, 102, 104, 106, 108, 110, 112, 114, 116, 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 146, 148, 150, 152, 154, 156, 158, 160, 162, 164, 166, 168, 170, 172, 174, 176, 178, 180, 182, 184, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204, 206, 208, 210, 212, 214, 216, 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240, 242, 244, 246, 248, 250, 252, 254, 256, 258, 260, 262, 264, 266, 268, 270, 272, 274, 276, 278, 280, 282, 284, 286, 288, 290, 292, 294, 296, 298, 300, 302, 304, 306, 308, 310, 312, 314, 316, 318, 320, 322, 324, 326, 328, 330, 332, 334, 336, 338, 340, 342, 344, 346, 348, 350, 352, 354, 356, 358, 360, 362, 364, 366, 368, 370, 372, 374, 376, 378, 380, 382, 384, 386, 388, 390, 392, 394, 396, 398, 400, 402, 404, 406, 408, 410, 412, 414, 416, 418, 420, 422, 424, 426, 428, 430, 432, 434, 436, 438, 440, 442, 444, 446, 448, 450, 452, 454, 456, 458, 460, 462, 464, 466, 468, 470, 472, 474, 476, 478, 480, 482, 484, 486, 488, 490, 492, 494, 496, 498, 500, 502, 504, 506, 508, 510, 512, 514, 516, 518, 520, 522, 524, 526, 528, 530, 532, 534, 536, 538, 540, 542, 544, 546, 548, 550, 552, 554, 556, 558, 560, 562, 564, 566, 568, 570, 572, 574, 576, 578, 580, 582, 584, 586, 588, 590, 592, 594, 596, 598, 600, 602, 604, 606, 608, 610, 612, 614, 616, 618, 620, 622, 624, 626, 628, 630, 632, 634, 636, 638, 640, 642, 644, 646, 648, 650, 652, 654, 656, 658, 660, 662, 664, 666, 668, 670, 672, 674, 676, 678, 680, 682, 684, 686, 688, 690, 692, 694, 696, 698, 700, 702, 704, 708, 710, 712, 714, 716, 718, 720, 722, 724, 726, 728, 730, 732, 734, 736, 738, 740, 742, 744, 746, 748, 750, 752, 754, 756, 758, 760, 762, 764, 766, 768, 770, 772, 774, 776, 778, 780, 782, 784, 786, 788, 790, 792, 794, 796, 798, 800, 802, 804, 806, 808, 810, 812, 814, 816, 818, 820, 822, 824, 826, 828, 830, 832, 834, 836, 838, 840, 842, 844, 846, 848, 850, 852, 854, 856, 858, 860, 862, 864, 866, 868, 870, 872, 874, 876, 878, 880, 882, 884, 886, 888, 890, 892, 894, 896, 898, 900, 902, 904, 906, 908, 910, 912, 914, 916, 918, 920, 922, 924, 926, 928, 930, 932, 934, 936, 938, 940, 942, 944, 946, 948, 950, 952, 954, 956, 958, 960, 962, 964, 966, 968, 970, 972, 974, 976, 978, 980, 982, 984, 986, 988, 990, 992, 994, 996, 998, 1000, 1002, 1004, 1006, 1008, 1010, 1012, 1014, 1016, 1018, 1020, 1022, 1024, 1026, 1028, 1030, 1032, 1034, 1036, 1038, 1040, 1042, 1044, 1046, 1048, 1050, 1052, 1054, 1056, 1058, 1060, 1062, 1064, 1066, 1068, 1070, 1072, 1074, 1076, 1078, 1080, 1082, 1084, 1086, 1088, 1090, 1092, 1094, 1096, 1098, 1100, 1102, 1104, 1106, 1108, 1110, 1112, 1114, 1116, 1118, 1120, 1122, 1124, 1126, 1128, 1130, 1132, 1134, 1136, 1138, 1140, 1142, 1144, 1146, 1148, 1150, 1152, 1154, 1156, 1158, 1160, 1162, 1164, 1166, 1168, 1170, 1172, 1174, 1176, 1178, 1180, 1182, 1184, 1186, 1188, 1190, 1192, 1194, 1196, 1198, 1200, 1202, 1204, 1206, 1208, 1210, 1212, 1214, 1216, 1218, 1220, 1222, 1224, 1226, 1228, 1230, 1232, 1234, 1236, 1238, 1240, 1242, 1244, 1246, 1248,

CT 1250, 1252, 1254, 1256, 1258, 1260, 1262, 1264, 1266, 1268, 1270, 1272, 1274, 1276, 1278, 1280, 1282, 1284, 1286, 1288, 1290, 1292, 1294, 1296, 1298, 1300, 1302, 1304, 1306, 1308, 1310, 1312, 1314, 1316, 1318, 1320, 1322, 1324, 1326, 1328, 1330, 1332, 1334, 1336, 1338, 1340, 1342, 1344, 1346, 1348, 1350, 1352, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372, 1374, 1376, 1378, 1380, 1382, 1384, 1386, 1388, 1390, 1392, 1394, 1396, 1398, 1400, 1402, 1404, 1406, 1408, 1410, 1412, 1414, 1416, 1418, 1420, 1422, 1424, 1426, 1428, 1430, 1432, 1434, 1436, 1438, 1440, 1442, 1444, 1446, 1448, 1450, 1452, 1454, 1456, 1458, 1460, 1462, 1464, 1466, 1468, 1470, 1472, 1474, 1476, 1478, 1480, 1482, 1484, 1486, 1488, 1490, 1492, 1494, 1496, 1498, 1500, 1502, 1504, 1506, 1508, 1510, 1512, 1514, 1516, 1518, 1520, 1522, 1524, 1526, 1528, 1530, 1532, 1534, 1536, 1538, 1540, 1542, 1544, 1546, 1548, 1550, 1552, 1554, 1556, 1558, 1560, 1562, 1564, 1566, 1568, 1570, 1572, 1574, 1576, 1578, 1580, 1582, 1584, 1586, 1588, 1590, 1592, 1594, 1596, 1598, 1600, 1602, 1604, 1606, 1608, 1610, 1612, 1614, 1616, 1618, 1620, 1622, 1624, 1626, 1628, 1630, 1632, 1634, 1636, 1638, 1640, 1642, 1644, 1646, 1648, 1650, 1652, 1654, 1656, 1658, 1660, 1662, 1664, 1666, 1668, 1670, 1672, 1674, 1676, 1678, 1680, 1682, 1684, 1686, 1688, 1690, 1692, 1694, 1696, 1698, 1700, 1702, 1704, 1706, 1708, 1710, 1712, 1714, 1716, 1718, 1720, 1722, 1724, 1726, 1728, 1730, 1732, 1734, 1736, 1738, 1740, 1742, 1744, 1746, 1748, 1750, 1752, 1754, 1756, 1758, 1760, 1762, 1764, 1766, 1768, 1770, 1772, 1774, 1776, 1778, 1780, 1782, 1784, 1786, 1788, 1790, 1792, 1794, 1796, 1798, 1800, 1802, 1804, 1806, 1808, 1810, 1812, 1814, 1816, 1818, 1820, 1822, 1824, 1826, 1828, 1830, 1832, 1834, 1836, 1838, 1840, 1842, 1844, 1846, 1848, 1850, 1852, 1854, 1856, 1858, 1860, 1862, 1864, 1866, 1868, 1870, 1872, 1874, 1876, 1878, 1880, 1882, 1884, 1886, 1888, 1890, 1892, 1894, 1896, 1898, 1900, 1902, 1904, 1906, 1908, 1910, 1912, 1914, 1916, 1918, 1920, 1922, 1924, 1926, 1928, 1930, 1932, 1934, 1936, 1938, 1940, 1942, 1944, 1946, 1948, 1950, 1952, 1954, 1956, 1958, 1960, 1962, 1964, 1966, 1968, 1970, 1972, 1974, 1976, 1978, 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, 2020, 2022, 2024, 2026, 2028, 2030, 2032, 2034, 2036, 2038, 2040, 2042, 2044, 2046, 2048, 2050, 2052, 2054, 2056, 2058, 2060, 2062, 2064, 2066, 2068, 2070, 2072, 2074, 2076, 2078, 2080, 2082, 2084, 2086, 2088, 2090, 2092, 2094, 2096, 2098, 2100, 2102, 2104, 2106, 2108, 2110, 2112, 2114, 2116, 2118, 2120, 2122, 2124, 2126, 2128, 2130, 2132, 2134, 2136, 2138, 2140, 2142, 2144, 2146, 2148, 2150, 2152, 2154, 2156, 2158, 2160, 2162, 2164, 2166, 2168, 2170, 2172, 2174, 2176, 2178, 2180, 2182, 2184, 2186, 2188, 2190, 2192, 2194, 2196, 2198, 2200, 2202, 2204, 2206, 2208, 2210, 2212, 2214, 2216, 2218, 2220, 2222, 2224, 2226, 2228, 2230, 2232, 2234, 2236, 2238, 2240, 2242, 2244, 2246, 2248, 2250, 2252, 2254, 2256, 2258, 2260, 2262, 2264, 2266, 2268, 2270, 2272, 2274, 2276, 2278, 2280, 2282, 2284, 2286, 2288, 2290, 2292, 2294, 2296, 2298, 2300, 2302, 2304, 2306, 2308, 2310, 2312, 2314, 2316, 2318, 2320, 2322, 2324, 2326, 2328, 2330, 2332, 2334, 2336, 2338, 2340, 2342, 2344, 2346, 2348, 2350, 2352, 2354, 2356, 2358, 2360, 2362, 2364, 2366, 2368, 2370, 2372, 2374, 2376, 2378, 2380, 2382, 2384, 2386, 2388,

2390, 2392, 2394, 2396, 2398, 2400, 2402, 2404, 2406, 2408, 2410, 2412, 2414, 2416, 2418, 2420, 2422, 2424, 2426, 2428, 2430, 2432, 2434, 2436, 2438, 2440, 2442, 2444, 2446, 2448, 2450, 2452, 2454, 2456, 2458, 2460, 2462, 2464, 2466, 2468, 2470, 2472, 2474, 2476, 2478, 2480, 2482, 2484, 2486, 2488, 2490, 2492, 2494, 2496, 2498, 2500, 2502, 2504, 2506, 2508, 2510, 2512, 2514, 2516, 2518, 2520, 2522, 2524, 2526, 2528, 2530, 2532, 2534, 2536, 2538, 2540, 2542, 2544, 2546, 2548, 2550, 2552, 2554, 2556, 2558, 2560, 2562, 2564, 2566, 2568, 2570, 2572, 2574, 2576, 2578, 2580, 2582, 2584, 2586, 2588, 2590, 2592, 2594, 2596, 2598, 2600, 2602, 2604, 2606, 2608, 2610, 2612, 2614, 2616, 2618, 2620, 2622, 2624, 2626, 2628, 2630, 2632, 2634, 2636, 2638, 2640, 2642, 2644, 2646, 2648, 2650, 2652, 2654, 2656, 2658, 2660, 2662, 2664, 2666, 2668, 2670, 2672, 2674, 2676, 2678, 2680, 2682, 2684, 2686, 2688, 2690, 2692, 2694, 2696, 2698, 2700, 2702, 2704, 2706, 2708, 2710, 2712, 2714, 2716, 2718, 2720, 2722, 2724, 2726, 2728, 2730, 2732, 2734, 2736, 2738, 2740, 2742, 2744, 2746, 2748, 2750, 2752, 2754, 2756, 2758, 2760, 2762, 2764, 2766, 2768, 2770, 2772, 2774, 2776, 2778, 2780, 2782, 2784, 2786, 2788, 2790, 2792, 2794, 2796, 2798, 2800, 2802, 2804, 2806, 2808, 2810, 2812, 2814, 2816, 2818, 2820, 2822, 2824, 2826, 2828, 2830, 2832, 2834, 2836, 2838, 2840, 2842, 2844, 2846, 2848, 2850, 2852, 2854, 2856, 2858, 2860, 2862, 2864, 2866, 2868, 2870, 2872, 2874, 2876, 2878, 2880, 2882, 2884, 2886, 2888, 2890, 2892, 2894, 2896, 2898, 2900, 2902, 2904, 2906, 2908, 2910, 2912, 2914, 2916, 2918, 2920, 2922, 2924, 2926, 2928, 2930, 2932, 2934, 2936, 2938, 2940, 2942, 2944, 2946, 2948, 2950, 2952, 2954, 2956, 2958, 2960, 2962, 2964, 2966, 2968, 2970, 2972, 2974, 2976, 2978, 2980, 2982, 2984, 2986, 2988, 2990, 2992, 2994, 2996, 2998, 3000, 3002, 3004, 3006, 3008, 3010, 3012, 3014, 3016, 3018, 3020, 3022, 3024, 3026, 3028, 3030, 3032, 3034, 3036, 3038, 3040, 3042, 3044, 3046, 3048, 3050, 3052, 3054, 3056, 3058, 3060, 3062, 3064, 3066, 3068, 3070, 3072, 3074, 3076, 3078, 3080, 3082, 3084, 3086, 3088, 3090, 3092, 3094, 3096, 3098, 3100, 3102, 3104, 3106, 3108, 3110, 3112, 3114, 3116, 3118, 3120, 3122, 3124, 3126, 3128, 3130, 3132, 3134, 3136, 3138, 3140, 3142, 3144, 3146, 3148, 3150, 3152, 3154, 3156, 3158, 3160, 3162, 3164, 3166, 3168, 3170, 3172, 3174, 3176, 3178, 3180, 3182, 3184, 3186, 3188, 3190, 3192, 3194, 3196, 3198, 3200, 3202, 3204, 3206, 3208, 3210, 3212, 3214, 3216, 3218, 3220, 3222, 3224, 3226, 3228, 3230, 3232, 3234, 3236, 3238, 3240, 3242, 3244, 3246, 3248, 3250, 3252, 3254, 3256, 3258, 3260, 3262, 3264, 3266, 3268, 3270, 3272, 3274, 3276, 3278, 3280, 3282, 3284, 3286, 3288, 3290, 3292, 3294, 3296, 3298, 3300, 3302, 3304, 3306, 3308, 3310, 3312, 3314, 3316, 3318, 3320, 3322, 3324, 3326, 3328, 3330, 3332, 3334, 3336, 3338, 3340, 3342, 3344, 3346, 3348, 3350, 3352, 3354, 3356, 3358, 3360, 3362, 3364, 3366, 3368, 3370, 3372, 3374, 3376, 3378, 3380, 3382, 3384, 3386, 3388, 3390, 3392, 3394, 3396, 3398, 3400, 3402, 3404, 3406, 3408, 3410, 3412, 3414, 3416, 3418, 3420, 3422, 3424, 3426, 3428, 3430, 3432, 3434, 3436, 3438, 3440, 3442, 3444, 3446, 3448, 3450, 3452, 3454, 3456, 3458, 3460, 3462, 3464, 3466, 3468, 3470, 3472, 3474, 3476, 3478, 3480, 3482, 3484, 3486, 3488, 3490, 3492, 3494, 3496, 3498, 3500, 3502, 3504, 3506, 3508, 3510, 3512, 3514, 3516, 3518, 3520, 3522, 3524, 3526, 3528,

3530, 3532, 3534, 3536, 3538, 3540, 3542, 3544, 3546, 3548, 3550, 3552, 3554, 3556, 3558, 3560, 3562, 3564, 3566, 3568, 3570, 3572, 3574, 3576, 3578, 3580, 3582, 3584, 3586, 3588, 3590, 3592, 3594, 3596, 3598, 3600, 3602, 3604, 3606, 3608, 3610, 3612, 3614, 3616, 3618, 3620, 3622, 3624, 3626, 3628, 3630, 3632, 3634, 3636, 3638, 3640, 3642, 3644, 3646, 3648, 3650, 3652, 3654, 3656, 3658, 3660, 3662, 3664, 3666, 3668, 3670, 3672, 3674, 3676, 3678, 3680, 3682, 3684, 3686, 3688, 3690, 3692, 3694, 3696, 3698, 3700, 3702, 3704, 3706, 3708, 3710, 3712, 3714, 3716, 3718, 3720, 3722, 3724, 3726, 3728, 3730, 3732, 3734, 3736, 3738, 3740, 3742, 3744, 3746, 3748, 3750, 3752, 3754, 3756, 3758, 3760, 3762, 3764, 3766, 3768, 3770, 3772, 3774, 3776, 3778, 3780, 3782, 3784, 3786, 3788, 3790, 3792, 3794, 3796, 3798, 3800, 3802, 3804, 3806, 3808, 3810, 3812, 3814, 3816, 3818, 3820, 3822, 3824, 3826, 3828, 3830, 3832, 3834, 3836, 3838, 3840, 3842, 3844, 3846, 3848, 3850, 3852, 3854, 3856, 3858, 3860, 3862, 3864, 3866, 3868, 3870, 3872, 3874, 3876, 3878, 3880, 3882, 3884, 3886, 3888, 3890, 3892, 3894, 3896, 3898, 3900, 3902, 3904, 3906, 3908, 3910, 3912, 3914, 3916, 3918, 3920, 3922, 3924, 3926, 3928, 3930, 3932, 3934, 3936, 3938, 3940, 3942, 3944, 3946, 3948, 3950, 3952, 3954, 3956, 3958, 3960, 3962, 3964, 3966, 3968, 3970, 3972, 3974, 3976, 3978, 3980, 3982, 3984, 3986, 3988, 3990, 3992, 3994, 3996, 3998, 4000, 4002, 4004, 4006, 4008, 4010, 4012, 4014, 4016, 4018, 4020, 4022, 4024, 4026, 4028, 4030, 4032, 4034, 4036, 4038, 4040, 4042, 4044, 4046, 4048, 4050, 4052, 4054, 4056, 4058, 4060, 4062, 4064, 4066, 4068, 4070, 4072, 4074, 4076, 4078, 4080, 4082, 4084, 4086, 4088, 4090, 4092, 4094, 4096, 4098, 4100, 4102, 4104, 4106, 4108, 4110, 4112, 4114, 4116, 4118, 4120, 4122, 4124, 4126, 4128, 4130, 4132, 4134, 4136, 4138, 4140, 4142, 4144, 4146, 4148, 4150, 4152, 4154, 4156, 4158, 4160, 4162, 4164, 4166, 4168, 4170, 4172, 4174, 4176, 4178, 4180, 4182, 4184, 4186, 4188, 4190, 4192, 4194, 4196, 4198, 4200, 4202, 4204, 4206, 4208, 4210, 4212, 4214, 4216, 4218, 4220, 4222, 4224, 4226, 4228, 4230, 4232, 4234, 4236, 4238, 4240, 4242, 4244, 4246, 4248, 4250, 4252, 4254, 4256, 4258, 4260, 4262, 4264, 4266, 4268, 4270, 4272, 4274, 4276, 4278, 4280, 4282, 4284, 4286, 4288, 4290, 4292, 4294, 4296, 4298, 4300, 4302, 4304, 4306, 4308, 4310, 4312, 4314, 4316, 4318, 4320, 4322, 4324, 4326, 4328, 4330, 4332, 4334, 4336, 4338, 4340, 4342, 4344, 4346, 4348, 4350, 4352, 4354, 4356, 4358, 4360, 4362, 4364, 4366, 4368, 4370, 4372, 4374, 4376, 4378, 4380, 4382, 4384, 4386, 4388, 4390, 4392, 4394, 4396, 4398, 4400, 4402, 4404, 4406, 4408, 4410, 4412, 4414, 4416, 4418, 4420, 4422, 4424, 4426, 4428, 4430, 4432, 4434, 4436, 4438, 4440, 4442, 4444, 4446, 4448, 4450, 4452, 4454, 4456, 4458, 4460, 4462, 4464, 4466, 4468, 4470, 4472, 4474, 4476, 4478, 4480, 4482, 4484, 4486, 4488, 4490, 4492, 4494, 4496, 4498, 4500, 4502, 4504, 4506, 4508, 4510, 4512, 4514, 4516, 4518, 4520, 4522, 4524, 4526, 4528, 4530, 4532, 4534, 4536, 4538, 4540, 4542, 4544, 4546, 4548, 4550, 4552, 4554, 4556, 4558, 4560, 4562, 4564, 4566, 4568, 4570, 4572, 4574, 4576, 4578, 4580, 4582, 4584, 4586, 4588, 4590, 4592, 4594, 4596, 4598, 4600, 4602, 4604, 4606, 4608, 4610, 4612, 4614, 4616, 4618, 4620, 4622, 4624, 4626, 4628, 4630, 4632, 4634, 4636, 4638, 4640, 4642, 4644, 4646, 4648, 4650, 4652, 4654, 4656, 4658, 4660, 4662, 4664, 4666, 4668,

4670, 4672, 4674, 4676, 4678, 4680, 4682, 4684, 4686, 4688, 4690, 4692, 4694, 4696, 4698, 4700, 4702, 4704, 4706, 4708, 4710, 4712, 4714, 4716, 4718, 4720, 4722, 4724, 4726, 4728, 4730, 4732, 4734, 4736, 4738, 4740, 4742, 4744, 4746, 4748, 4750, 4752, 4754, 4756, 4758, 4760, 4762, 4764, 4766, 4768, 4770, 4772, 4774, 4776, 4778, 4780, 4782, 4784, 4786, 4788, 4790, 4792, 4794, 4796, 4798, 4800, 4802, 4804, 4806, 4808, 4810, 4812, 4814, 4816, 4818, 4820, 4822, 4824, 4826, 4828, 4830, 4832, 4834, 4836, 4838, 4840, 4842, 4844, 4846, 4848, 4850, 4852, 4854, 4856, 4858, 4860, 4862, 4864, 4866, 4868, 4870, 4872, 4874, 4876, 4878, 4880, 4882, 4884, 4886, 4888, 4890, 4892, 4894, 4896, 4898, 4900, 4902, 4904, 4906, 4908, 4910, 4912, 4914, 4916, 4918, 4920, 4922, 4924, 4926, 4928, 4930, 4932, 4934, 4936, 4938, 4940, 4942, 4944, 4946, 4948, 4950, 4952, 4954, 4956, 4958, 4960, 4962, 4964, 4966, 4968, 4970, 4972, 4974, 4976, 4978, 4980, 4982, 4984, 4986, 4988, 4990, 4992, 4994, 4996, 4998, 5000, 5002, 5004, 5006, 5008, 5010, 5012, 5014, 5016, 5018, 5020, 5022, 5024, 5026, 5028, 5030, 5032, 5034, 5036, 5038, 5040, 5042, 5044, 5046, 5048, 5050, 5052, 5054, 5056, 5058, 5060, 5062, 5064, 5066, 5068, 5070, 5072, 5074, 5076, 5078, 5080, 5082, 5084, 5086, 5088, 5090, 5092, 5094, 5096, 5098, 5100, 5102, 5104, 5106, 5108, 5110, 5112, 5114, 5116, 5118, 5120, 5122, 5124, 5126, 5128, 5130, 5132, 5134, 5136, 5138, 5140, 5142, 5144, 5146, 5148, 5150, 5152, 5154, 5156, 5158, 5160, 5162, 5164, 5166, 5168, 5170, 5172, 5174, 5176, 5178, 5180, 5182, 5184, 5186, 5188, 5190, 5192, 5194, 5196, 5198, 5200, 5202, 5204, 5206, 5208, 5210, 5212, 5214, 5216, 5218, 5220, 5222, 5224, 5226, 5228, 5230, 5232, 5234, 5236, 5238, 5240, 5242, 5244, 5246, 5248, 5250, 5252, 5254, 5256, 5258, 5260, 5262, 5264, 5266, 5268, 5270, 5272, 5274, 5276, 5278, 5280, 5282, 5284, 5286, 5288, 5290, 5292, 5294, 5296, 5298, 5300, 5302, 5304, 5306, 5308, 5310, 5312, 5314, 5316, 5318, 5320, 5322, 5324, 5326, 5328, 5330, 5332, 5334, 5336, 5338, 5340, 5342, 5344, 5346, 5348, 5350, 5352, 5354, 5356, 5358, 5360, 5362, 5364, 5366, 5368, 5370, 5372, 5374, 5376, 5378, 5380, 5382, 5384, 5386, 5388, 5390, 5392, 5394, 5396, 5398, 5400, 5402, 5404, 5406, 5408, 5410, 5412, 5414, 5416, 5418, 5420, 5422, 5424, 5426, 5428, 5430, 5432, 5434, 5436, 5438, 5440, 5442, 5444, 5446, 5448, 5450, 5452, 5454, 5456, 5458, 5460, 5462, 5464, 5466, 5468, 5470, 5472, 5474, 5476, 5478, 5480, 5482, 5484, 5486, 5488, 5490, 5492, 5494, 5496, 5498, 5500, 5502, 5504, 5506, 5508, 5510, 5512, 5514, 5516, 5518, 5520, 5522, 5524, 5526, 5528, 5530, 5532, 5534, 5536, 5538, 5540, 5542, 5544, 5546, 5548, 5550, 5552, 5554, 5556, 5558, 5560, 5562, 5564, 5566, 5568, 5570, 5572, 5574, 5576, 5578, 5580, 5582, 5584, 5586, 5588, 5590, 5592, 5594, 5596, 5598, 5600, 5602, 5604, 5606, 5608, 5610, 5612, 5614, 5616, 5618, 5620, 5622, 5624, 5626, 5628, 5630, 5632, 5634, 5636, 5638, 5640, 5642, 5644, 5646, 5648, 5650, 5652, 5654, 5656, 5658, 5660, 5662, 5664, 5666, 5668, 5670, 5672, 5674, 5676, 5678, 5680, 5682, 5684, 5686, 5688, 5690, 5692, 5694, 5696, 5698, 5700, 5702, 5704, 5706, 5708, 5710, 5712, 5714, 5716, 5718, 5720, 5722, 5724, 5726, 5728, 5730, 5732, 5734, 5736, 5738, 5740, 5742, 5744, 5746, 5748, 5750, 5752, 5754, 5756, 5758, 5760, 5762, 5764, 5766, 5768, 5770, 5772, 5774, 5776, 5778, 5780, 5782, 5784, 5786, 5788, 5790, 5792, 5794, 5796, 5798, 5800, 5802, 5804, 5806, 5808,

5810, 5812, 5814, 5816, 5818, 5820, 5822, 5824, 5826, 5828, 5830, 5832, 5834, 5836, 5838, 5840, 5842, 5844, 5846, 5848, 5850, 5852, 5854, 5856, 5858, 5860, 5862, 5864, 5866, 5868, 5870, 5872, 5874, 5876, 5878, 5880, 5882, 5884, 5886, 5888, 5890, 5892, 5894, 5896, 5898, 5900, 5902, 5904, 5906, 5908, 5910, 5912, 5914, 5916, 5918, 5920, 5922, 5924, 5926, 5928, 5930, 5932, 5934, 5936, 5938, 5940, 5942, 5944, 5946, 5948, 5950, 5952, 5954, 5956, 5958, 5960, 5962, 5964, 5966, 5968, 5970, 5972, 5974, 5976, 5978, 5980, 5982, 5984, 5986, 5988, 5990, 5992, 5994, 5996, 5998, 6000, 6002, 6004, 6006, 6008, 6010, 6012, 6014, 6016, 6018, 6020, 6022, 6024, 6026, 6028, 6030, 6032, 6034, 6036, 6038, 6040, 6042, 6044, 6046, 6048, 6050, 6052, 6054, 6056, 6058, 6060, 6062, 6064, 6066, 6068, 6070, 6072, 6074, 6076, 6078, 6080, 6082, 6084, 6086, 6088, 6090, 6092, 6094, 6096, 6098, 6100, 6102, 6104, 6106, 6108, 6110, 6112, 6114, 6116, 6118, 6120, 6122, 6124, 6126, 6128, 6130, 6132, 6134, 6136, 6138, 6140, 6142, 6144, 6146, 6148, 6150, 6152, 6154, 6156, 6158, 6160, 6162, 6164, 6166, 6168, 6170, 6172, 6174, 6176, 6178, 6180, 6182, 6184, 6186, 6188, 6190, 6192, 6194, 6196, 6198, 6200, 6202, 6204, 6206, 6208, 6210, 6212, 6214, 6216, 6218, 6220, 6222, 6224, 6226, 6228, 6230, 6232, 6234, 6236, 6238, 6240, 6242, 6244, 6246, 6248, 6250, 6252, 6254, 6256, 6258, 6260, 6262, 6264, 6266, 6268, 6270, 6272, 6274, 6276, 6278, 6280, 6282, 6284, 6286, 6288, 6290, 6292, 6294, 6296, 6298, 6300, 6302, 6304, 6306, 6308, 6310, 6312, 6314, 6316, 6318, 6320, 6322, 6324, 6326, 6328, 6330, 6332, 6334, 6336, 6338, 6340, 6342, 6344, 6346, 6348, 6350, 6352, 6354, 6356, 6358, 6360, 6362, 6364, 6366, 6368, 6370, 6372, 6374, 6376, 6378, 6380, 6382, 6384, 6386, 6388, 6390, 6392, 6394, 6396, 6398, 6400, 6402, 6404, 6406, 6408, 6410, 6412, 6414, 6416, 6418, 6420, 6422, 6424, 6426, 6428, 6430, 6432, 6434, 6436, 6438, 6440, 6442, 6444, 6446, 6448, 6450, 6452, 6454, 6456, 6458, 6460, 6462, 6464, 6466, 6468, 6470, 6472, 6474, 6476, 6478, 6480, 6482, 6484, 6486, 6488, 6490, 6492, 6494, 6496, 6498, 6500, 6502, 6504, 6506, 6508, 6510, 6512, 6514, 6516, 6518, 6520, 6522, 6524, 6526, 6528, 6530, 6532, 6534, 6536, 6538, 6540, 6542, 6544, 6546, 6548, 6550, 6552, 6554, 6556, 6558, 6560, 6562, 6564, 6566, 6568, 6570, 6572, 6574, 6576, 6578, 6580, 6582, 6584, 6586, 6588, 6590, 6592, 6594, 6596, 6598, 6600, 6602, 6604, 6606, 6608, 6610, 6612, 6614, 6616, 6618, 6620, 6622, 6624, 6626, 6628, 6630, 6632, 6634, 6636, 6638, 6640, 6642, 6644, 6646, 6648, 6650, 6652, 6654, 6656, 6658, 6660, 6662, 6664, 6666, 6668, 6670, 6672, 6674, 6676, 6678, 6680, 6682, 6684, 6686, 6688, 6690, 6692, 6694, 6696, 6698, 6700, 6702, 6704, 6706, 6708, 6710, 6712, 6714, 6716, 6718, 6720, 6722, 6724, 6726, 6728, 6730, 6732, 6734, 6736, 6738, 6740, 6742, 6744, 6746, 6748, 6750, 6752, 6754, 6756, 6758, 6760, 6762, 6764, 6766, 6768, 6770, 6772, 6774, 6776, 6778, 6780, 6782, 6784, 6786, 6788, 6790, 6792, 6794, 6796, 6798, 6800, 6802, 6804, 6806, 6808, 6810, 6812, 6814, 6816, 6818, 6820, 6822, 6824, 6826, 6828, 6830, 6832, 6834, 6836, 6838, 6840, 6842, 6844, 6846, 6848, 6850, 6852, 6854, 6856, 6858, 6860, 6862, 6864, 6866, 6868, 6870, 6872, 6874, 6876, 6878, 6880, 6882, 6884, 6886, 6888, 6890, 6892, 6894, 6896, 6898, 6900, 6902, 6904, 6906, 6908, 6910, 6912, 6914, 6916, 6918, 6920, 6922, 6924, 6926, 6928, 6930, 6932, 6934, 6936, 6938, 6940, 6942, 6944, 6946, 6948,

6950, 6952, 6954, 6956, 6958, 6960, 6962, 6964, 6966, 6968, 6970, 6972, 6974, 6976, 6978, 6980, 6982, 6984, 6986, 6988, 6990, 6992, 6994, 6996, 6998, 7000, 7002, 7004, 7006, 7008, 7010, 7012, 7014, 7016, 7018, 7020, 7022, 7024, 7026, 7028, 7030, 7032, 7034, 7036, 7038, 7040, 7042, 7044, 7046, 7048, 7050, 7052, 7054, 7056, 7058, 7060, 7062, 7064, 7066, 7068, 7070, 7072, 7074, 7076, 7078, 7080, 7082, 7084, 7086, 7088, 7090, 7092, 7094, 7096, 7098, 7100, 7102, 7104, 7106, 7108, 7110, 7112, 7114, 7116, 7118, 7120, 7122, 7124, 7126, 7128, 7130, 7132, 7134, 7136, 7138, 7140, 7142, 7144, 7146, 7148, 7150, 7152, 7154, 7156, 7158, 7160, 7162, 7164, 7166, 7168, 7170, 7172, 7174, 7176, 7178, 7180, 7182, 7184, 7186, 7188, 7190, 7192, 7194, 7196, 7198, 7200, 7202, 7204, 7206, 7208, 7210, 7212, 7214, 7216, 7218, 7220, 7222, 7224, 7226, 7228, 7230, 7232, 7234, 7236, 7238, 7240, 7242, 7244, 7246, 7248, 7250, 7252, 7254, 7256, 7258, 7260, 7262, 7264, 7266, 7268, 7270, 7272, 7274, 7276, 7278, 7280, 7282, 7284, 7286, 7288, 7290, 7292, 7294, 7296, 7298, 7300, 7302, 7304, 7306, 7308, 7310, 7312, 7314, 7316, 7318, 7320, 7322, 7324, 7326, 7328, 7330, 7332, 7334, 7336, 7338, 7340, 7342, 7344, 7346, 7348, 7350, 7352, 7354, 7356, 7358, 7360, 7362, 7364, 7366, 7368, 7370, 7372, 7374, 7376, 7378, 7380, 7382, 7384, 7386, 7388, 7390, 7392, 7394, 7396, 7398, 7400, 7402, 7404, 7406, 7408, 7410, 7412, 7414, 7416, 7418, 7420, 7422, 7424, 7426, 7428, 7430, 7432, 7434, 7436, 7438, 7440, 7442, 7444, 7446, 7448, 7450, 7452, 7454, 7456, 7458, 7460, 7462, 7464, 7466, 7468, 7470, 7472, 7474, 7476, 7478, 7480, 7482, 7484, 7486, 7488, 7490, 7492, 7494, 7496, 7498, 7500, 7502, 7504, 7506, 7508, 7510, 7512, 7514, 7516, 7518, 7520, 7522, 7524, 7526, 7528, 7530, 7532, 7534, 7536, 7538, 7540, 7542, 7544, 7546, 7548, 7550, 7552, 7554, 7556, 7558, 7560, 7562, 7564, 7566, 7568, 7570, 7572, 7574, 7576, 7578, 7580, 7582, 7584, 7586, 7588, 7590, 7592, 7594, 7596, 7598, 7600, 7602, 7604, 7606, 7608, 7610, 7612, 7614, 7616, 7618, 7620, 7622, 7624, 7626, 7628, 7630, 7632, 7634, 7636, 7638, 7640, 7642, 7644, 7646, 7648, 7650, 7652, 7654, 7656, 7658, 7660, 7662, 7664, 7666, 7668, 7670, 7672, 7674, 7676, 7678, 7680, 7682, 7684, 7686, 7688, 7690, 7692, 7694, 7696, 7698, 7700, 7702, 7704, 7706, 7708, 7710, 7712, 7714, 7716, 7718, 7720, 7722, 7724, 7726, 7728, 7730, 7732, 7734, 7736, 7738, 7740, 7742, 7744, 7746, 7748, 7750, 7752, 7754, 7756, 7758, 7760, 7762, 7764, 7766, 7768, 7770, 7772, 7774, 7776, 7778, 7780, 7782, 7784, 7786, 7788, 7790, 7792, 7794, 7796, 7798, 7800, 7802, 7804, 7806, 7808, 7810, 7812, 7814, 7816, 7818, 7820, 7822, 7824, 7826, 7828, 7830, 7832, 7834, 7836, 7838, 7840, 7842, 7844, 7846, 7848, 7850, 7852, 7854, 7856, 7858, 7860, 7862, 7864, 7866, 7868, 7870, 7872, 7874, 7876, 7878, 7880, 7882, 7884, 7886, 7888, 7890, 7892, 7894, 7896, 7898, 7900, 7902, 7904, 7906, 7908, 7910, 7912, 7914, 7916, 7918, 7920, 7922, 7924, 7926, 7928, 7930, 7932, 7934, 7936, 7938, 7940, 7942, 7944, 7946, 7948, 7950, 7952, 7954, 7956, 7958, 7960, 7962, 7964, 7966, 7968, 7970, 7972, 7974, 7976, 7978, 7980, 7982, 7984, 7986, 7988, 7990, 7992, 7994, 7996, 7998, 8000, 8002, 8004, 8006, 8008, 8010, 8012, 8014, 8016, 8018, 8020, 8022, 8024, 8026, 8028, 8030, 8032, 8034, 8036, 8038, 8040, 8042, 8044, 8046, 8048, 8050, 8052, 8054, 8056, 8058, 8060, 8062, 8064, 8066, 8068, 8070, 8072, 8074, 8076, 8078, 8080, 8082, 8084, 8086, 8088,

8090, 8092, 8094, 8096, 8098, 8100, 8102, 8104, 8106, 8108, 8110, 8112, 8114, 8116, 8118, 8120, 8122, 8124, 8126, 8128, 8130, 8132, 8134, 8136, 8138, 8140, 8142, 8144, 8146, 8148, 8150, 8152, 8154, 8156, 8158, 8160, 8162, 8164, 8166, 8168, 8170, 8172, 8174, 8176, 8178, 8180, 8182, 8184, 8186, 8188, 8190, 8192, 8194, 8196, 8198, 8200, 8202, 8204, 8206, 8208, 8210, 8212, 8214, 8216, 8218, 8220, 8222, 8224, 8226, 8228, 8230, 8232, 8234, 8236, 8238, 8240, 8242, 8244, 8246, 8248, 8250, 8252, 8254, 8256, 8258, 8260, 8262, 8264, 8266, 8268, 8270, 8272, 8274, 8276, 8278, 8280, 8282, 8284, 8286, 8288, 8290, 8292, 8294, 8296, 8298, 8300, 8302, 8304, 8306, 8308, 8310, 8312, 8314, 8316, 8318, 8320, 8322, 8324, 8326, 8328, 8330, 8332, 8334, 8336, 8338, 8340, 8342, 8344, 8346, 8348, 8350, 8352, 8354, 8356, 8358, 8360, 8362, 8364, 8366, 8368, 8370, 8372, 8374, 8376, 8378, 8380, 8382, 8384, 8386, 8388, 8390, 8392, 8394, 8396, 8398, 8400, 8402, 8404, 8406, 8408, 8410, 8412, 8414, 8416, 8418, 8420, 8422, 8424, 8426, 8428, 8430, 8432, 8434, 8436, 8438, 8440, 8442, 8444, 8446, 8448, 8450, 8452, 8454, 8456, 8458, 8460, 8462, 8464, 8466, 8468, 8470, 8472, 8474, 8476, 8478, 8480, 8482, 8484, 8486, 8488, 8490, 8492, 8494, 8496, 8498, 8500, 8502, 8504, 8506, 8508, 8510, 8512, 8514, 8516, 8518, 8520, 8522, 8524, 8526, 8528, 8530, 8532, 8534, 8536, 8538, 8540, 8542, 8544, 8546, 8548, 8550, 8552, 8554, 8556, 8558, 8560, 8562, 8564, 8566, 8568, 8570, 8572, 8574, 8576, 8578, 8580, 8582, 8584, 8586, 8588, 8590, 8592, 8594, 8596, 8598, 8600, 8602, 8604, 8606, 8608, 8610, 8612, 8614, 8616, 8618, 8620, 8622, 8624, 8626, 8628, 8630, 8632, 8634, 8636, 8638, 8640, 8642, 8644, 8646, 8648, 8650, 8652, 8654, 8656, 8658, 8660, 8662, 8664, 8666, 8668, 8670, 8672, 8674, 8676, 8678, 8680, 8682, 8684, 8686, 8688, 8690, 8692, 8694, 8696, 8698, 8700, 8702, 8704, 8706, 8708, 8710, 8712, 8714, 8716, 8718, 8720, 8722, 8724, 8726, 8728, 8730, 8732, 8734, 8736, 8738, 8740, 8742, 8744, 8746, 8748, 8750, 8752, 8754, 8756, 8758, 8760, 8762, 8764, 8766, 8768, 8770, 8772, 8774, 8776, 8778, 8780, 8782, 8784, 8786, 8788, 8790, 8792, 8794, 8796, 8798, 8800, 8802, 8804, 8806, 8808, 8810, 8812, 8814, 8816, 8818, 8820, 8822, 8824, 8826, 8828, 8830, 8832, 8834, 8836, 8838, 8840, 8842, 8844, 8846, 8848, 8850, 8852, 8854, 8856, 8858, 8860, 8862, 8864, 8866, 8868, 8870, 8872, 8874, 8876, 8878, 8880, 8882, 8884, 8886, 8888, 8890, 8892, 8894, 8896, 8898, 8900, 8902, 8904, 8906, 8908, 8910, 8912, 8914, 8916, 8918, 8920, 8922, 8924, 8926, 8928, 8930, 8932, 8934, 8936, 8938, 8940, 8942, 8944, 8946, 8948, 8950, 8952, 8954, 8956, 8958, 8960, 8962, 8964, 8966, 8968, 8970, 8972, 8974, 8976, 8978, 8980, 8982, 8984, 8986, 8988, 8990, 8992, 8994, 8996, 8998, 9000, 9002, 9004, 9006, 9008, 9010, 9012, 9014, 9016, 9018, 9020, 9022, 9024, 9026, 9028, 9030, 9032, 9034, 9036, 9038, 9040, 9042, 9044, 9046, 9048, 9050, 9052, 9054, 9056, 9058, 9060, 9062, 9064, 9066, 9068, 9070, 9072, 9074, 9076, 9078, 9080, 9082, 9084, 9086, 9088, 9090, 9092, 9094, 9096, 9098, 9100, 9102, 9104, 9106, 9108, 9110, 9112, 9114, 9116, 9118, 9120, 9122, 9124, 9126, 9128, 9130, 9132, 9134, 9136, 9138, 9140, 9142, 9144, 9146, 9148, 9150, 9152, 9154, 9156, 9158, 9160, 9162, 9164, 9166, 9168, 9170, 9172, 9174, 9176, 9178, 9180, 9182, 9184, 9186, 9188, 9190, 9192, 9194, 9196, 9198, 9200, 9202, 9204, 9206, 9208, 9210, 9212, 9214, 9216, 9218, 9220, 9222, 9224, 9226, 9228,

9230, 9232, 9234, 9236, 9238, 9240, 9242, 9244, 9246, 9248, 9250, 9252, 9254, 9256, 9258, 9260, 9262, 9264, 9266, 9268, 9270, 9272, 9274, 9276, 9278, 9280, 9282, 9284, 9286, 9288, 9290, 9292, 9294, 9296, 9298, 9300, 9302, 9304, 9306, 9308, 9310, 9312, 9314, 9316, 9318, 9320, 9322, 9324, 9326, 9328, 9330, 9332, 9334, 9336, 9338, 9340, 9342, 9344, 9346, 9348, 9350, 9352, 9354, 9356, 9358, 9360, 9362, 9364, 9366, 9368, 9370, 9372, 9374, 9376, 9378, 9380, 9382, 9384, 9386, 9388, 9390, 9392, 9394, 9396, 9398, 9400, 9402, 9404, 9406, 9408, 9410, 9412, 9414, 9416, 9418, 9420, 9422, 9424, 9426, 9428, 9430, 9432, 9434, 9436, 9438, 9440, 9442, 9444, 9446, 9448, 9450, 9452, 9454, 9456, 9458, 9460, 9462, 9464, 9466, 9468, 9470, 9472, 9474, 9476, 9478, 9480, 9482, 9484, 9486, 9488, 9490, 9492, 9494, 9496, 9498, 9500, 9502, 9504, 9506, 9508, 9510, 9512, 9514, 9516, 9518, 9520, 9522, 9524, 9526, 9528, 9530, 9532, 9534, 9536, 9538, 9540, 9542, 9544, 9546, 9548, 9550, 9552, 9554, 9556, 9558, 9560, 9562, 9564, 9566, 9568, 9570, 9572, 9574, 9576, 9578, 9580, 9582, 9584, 9586, 9588, 9590, 9592, 9594, 9596, 9598, 9600, 9602, 9604, 9606, 9608, 9610, 9612, 9614, 9616, 9618, 9620, 9622, 9624, 9626, 9628, 9630, 9632, 9634, 9636, 9638, 9640, 9642, 9644, 9646, 9648, 9650, 9652, 9654, 9656, 9658, 9660, 9662, 9664, 9666, 9668, 9670, 9672, 9674, 9676, 9678, 9680, 9682, 9684, 9686, 9688, 9690, 9692, 9694, 9696, 9698, 9700, 9702, 9704, 9706, 9708, 9710, 9712, 9714, 9716, 9718, 9720, 9722, 9724, 9726, 9728, 9730, 9732, 9734, 9736, 9738, 9740, 9742, 9744, 9746, 9748, 9750, 9752, 9754, 9756, 9758, 9760, 9762, 9764, 9766, 9768, 9770, 9772, 9774, 9776, 9778, 9780, 9782, 9784, 9786, 9788, 9790, 9792, 9794, 9796, 9798, 9800, 9802, 9804, 9806, 9808, 9810, 9812, 9814, 9816, 9818, 9820, 9822, 9824, 9826, 9828, 9830, 9832, 9834, 9836, 9838, 9840, 9842, 9844, 9846, 9848, 9850, 9852, 9854, 9856, 9858, 9860, 9862, 9864, 9866, 9868, 9870, 9872, 9874, 9876, 9878, 9880, 9882, 9884, 9886, 9888, 9890, 9892, 9894, 9896, 9898, 9900, 9902, 9904, 9906, 9908, 9910, 9912, 9914, 9916, 9918, 9920, 9922, 9924, 9926, 9928, 9930, 9932, 9934, 9936, 9938, 9940, 9942, 9944, 9946, 9948, 9950, 9952, 9954, 9956, 9958, 9960, 9962, 9964, 9966, 9968, 9970, 9972, 9974, 9976, 9978, 9980, 9982, 9984, 9986, 9988 and 9990; (b) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) an amino acid sequence which is a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a); or (d) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a) and including a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a).

2. The polypeptide of claim 1 comprising: (a) an amino acid sequence selected from the group consisting of SEQ ID NOs 512, 2454, 2456, 2678, 2692, 4596, 4748, 7004, 7052, 8168, 4628 and 5700; (b) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) an amino acid sequence which is a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a); or (d) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a) and including a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a).

3. The polypeptide of claim 1 comprising: (a) an amino acid sequence selected from the group consisting of SEQ ID NOs 8564, 2728, 9872, 4672, 5680, 534, 3222, 3226 and 7004; (b) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) an amino acid sequence which is a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a); or (d) an amino acid sequence having at least 80% sequence identity to an amino acid sequence of (a) and including a fragment of at least 10 consecutive amino acids from an amino acid sequence of (a).

4. The polypeptide of any one of claims 1 to 3, wherein said fragment comprises at least one B-cell epitope of (a).

5. The polypeptide of any one of claims 1 to 4, for use in medicine.

6. Nucleic acid comprising: (a) a nucleotide sequence selected from the group consisting of SEQ ID NOs 705, 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137, 139, 141, 143, 145, 147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169, 171, 173, 175, 177, 179, 181, 183, 185, 187, 189, 191, 193, 195, 197, 199, 201, 203, 205, 207, 209, 211, 213, 215, 217, 219, 221, 223, 225, 227, 229, 231, 233, 235, 237, 239, 241, 243, 245, 247, 249, 251, 253, 255, 257, 259, 261, 263, 265, 267, 269, 271, 273, 275, 277, 279, 281, 283, 285, 287, 289, 291, 293, 295, 297, 299, 301, 303, 305, 307, 309, 311, 313, 315, 317, 319, 321, 323, 325, 327, 329, 331, 333, 335, 337, 339, 341, 343, 345, 347, 349, 351, 353, 355, 357, 359, 361, 363, 365, 367, 369, 371, 373, 375, 377, 379, 381, 383, 385, 387, 389, 391, 393, 395, 397, 399, 401, 403, 405, 407, 409, 411, 413, 415, 417, 419, 421, 423, 425, 427, 429, 431, 433, 435, 437, 439, 441, 443, 445, 447, 449, 451, 453, 455, 457, 459, 461, 463, 465, 467, 469, 471, 473, 475, 477, 479, 481, 483, 485, 487, 489, 491, 493, 495, 497, 499, 501, 503, 505, 507, 509, 511, 513, 515, 517, 519, 521, 523, 525, 527, 529, 531, 533, 535, 537, 539, 541, 543, 545, 547, 549, 551, 553, 555, 557, 559, 561, 563, 565, 567, 569, 571, 573, 575, 577, 579, 581, 583, 585, 587, 589, 591, 593, 595, 597, 599, 601, 603, 605, 607, 609, 611, 613, 615, 617, 619, 621, 623, 625, 627, 629, 631, 633, 635, 637, 639, 641, 643, 645, 647, 649, 651, 653, 655, 657, 659, 661, 663, 665, 667, 669, 671, 673, 675, 677, 679, 681, 683, 685, 687, 689, 691, 693, 695, 697, 699, 701, 703, 707, 709, 711, 713, 715, 717, 719, 721, 723, 725, 727, 729, 731, 733, 735, 737, 739, 741, 743, 745, 747, 749, 751, 753, 755, 757, 759, 761, 763, 765, 767, 769, 771, 773, 775, 777, 779, 781, 783, 785, 787, 789, 791, 793, 795, 797, 799, 801, 803, 805, 807, 809, 811, 813, 815, 817, 819, 821, 823, 825, 827, 829, 831, 833, 835, 837, 839, 841, 843, 845, 847, 849, 851, 853, 855, 857, 859, 861, 863, 865, 867, 869, 871, 873, 875, 877, 879, 881, 883, 885, 887, 889, 891, 893, 895, 897, 899, 901, 903, 905, 907, 909, 911, 913, 915, 917, 919, 921, 923, 925, 927, 929, 931, 933, 935, 937, 939, 941, 943, 945, 947, 949, 951, 953, 955, 957, 959, 961, 963, 965, 967, 969, 971, 973, 975, 977, 979, 981, 983, 985, 987, 989, 991, 993, 995, 997, 999, 1001, 1003, 1005, 1007, 1009, 1011,

1013, 1015, 1017, 1019, 1021, 1023, 1025, 1027, 1029, 1031, 1033, 1035, 1037, 1039, 1041,
1043, 1045, 1047, 1049, 1051, 1053, 1055, 1057, 1059, 1061, 1063, 1065, 1067, 1069, 1071,
1073, 1075, 1077, 1079, 1081, 1083, 1085, 1087, 1089, 1091, 1093, 1095, 1097, 1099, 1101,
1103, 1105, 1107, 1109, 1111, 1113, 1115, 1117, 1119, 1121, 1123, 1125, 1127, 1129, 1131,
1133, 1135, 1137, 1139, 1141, 1143, 1145, 1147, 1149, 1151, 1153, 1155, 1157, 1159, 1161,
1163, 1165, 1167, 1169, 1171, 1173, 1175, 1177, 1179, 1181, 1183, 1185, 1187, 1189, 1191,
1193, 1195, 1197, 1199, 1201, 1203, 1205, 1207, 1209, 1211, 1213, 1215, 1217, 1219, 1221,
1223, 1225, 1227, 1229, 1231, 1233, 1235, 1237, 1239, 1241, 1243, 1245, 1247, 1249, 1251,
1253, 1255, 1257, 1259, 1261, 1263, 1265, 1267, 1269, 1271, 1273, 1275, 1277, 1279, 1281,
1283, 1285, 1287, 1289, 1291, 1293, 1295, 1297, 1299, 1301, 1303, 1305, 1307, 1309, 1311,
1313, 1315, 1317, 1319, 1321, 1323, 1325, 1327, 1329, 1331, 1333, 1335, 1337, 1339, 1341,
1343, 1345, 1347, 1349, 1351, 1353, 1355, 1357, 1359, 1361, 1363, 1365, 1367, 1369, 1371,
1373, 1375, 1377, 1379, 1381, 1383, 1385, 1387, 1389, 1391, 1393, 1395, 1397, 1399, 1401,
1403, 1405, 1407, 1409, 1411, 1413, 1415, 1417, 1419, 1421, 1423, 1425, 1427, 1429, 1431,
1433, 1435, 1437, 1439, 1441, 1443, 1445, 1447, 1449, 1451, 1453, 1455, 1457, 1459, 1461,
1463, 1465, 1467, 1469, 1471, 1473, 1475, 1477, 1479, 1481, 1483, 1485, 1487, 1489, 1491,
1493, 1495, 1497, 1499, 1501, 1503, 1505, 1507, 1509, 1511, 1513, 1515, 1517, 1519, 1521,
1523, 1525, 1527, 1529, 1531, 1533, 1535, 1537, 1539, 1541, 1543, 1545, 1547, 1549, 1551,
1553, 1555, 1557, 1559, 1561, 1563, 1565, 1567, 1569, 1571, 1573, 1575, 1577, 1579, 1581,
1583, 1585, 1587, 1589, 1591, 1593, 1595, 1597, 1599, 1601, 1603, 1605, 1607, 1609, 1611,
1613, 1615, 1617, 1619, 1621, 1623, 1625, 1627, 1629, 1631, 1633, 1635, 1637, 1639, 1641,
1643, 1645, 1647, 1649, 1651, 1653, 1655, 1657, 1659, 1661, 1663, 1665, 1667, 1669, 1671,
1673, 1675, 1677, 1679, 1681, 1683, 1685, 1687, 1689, 1691, 1693, 1695, 1697, 1699, 1701,
1703, 1705, 1707, 1709, 1711, 1713, 1715, 1717, 1719, 1721, 1723, 1725, 1727, 1729, 1731,
1733, 1735, 1737, 1739, 1741, 1743, 1745, 1747, 1749, 1751, 1753, 1755, 1757, 1759, 1761,
1763, 1765, 1767, 1769, 1771, 1773, 1775, 1777, 1779, 1781, 1783, 1785, 1787, 1789, 1791,
1793, 1795, 1797, 1799, 1801, 1803, 1805, 1807, 1809, 1811, 1813, 1815, 1817, 1819, 1821,
1823, 1825, 1827, 1829, 1831, 1833, 1835, 1837, 1839, 1841, 1843, 1845, 1847, 1849, 1851,
1853, 1855, 1857, 1859, 1861, 1863, 1865, 1867, 1869, 1871, 1873, 1875, 1877, 1879, 1881,
1883, 1885, 1887, 1889, 1891, 1893, 1895, 1897, 1899, 1901, 1903, 1905, 1907, 1909, 1911,
1913, 1915, 1917, 1919, 1921, 1923, 1925, 1927, 1929, 1931, 1933, 1935, 1937, 1939, 1941,
1943, 1945, 1947, 1949, 1951, 1953, 1955, 1957, 1959, 1961, 1963, 1965, 1967, 1969, 1971,
1973, 1975, 1977, 1979, 1981, 1983, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001,
2003, 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021, 2023, 2025, 2027, 2029, 2031,
2033, 2035, 2037, 2039, 2041, 2043, 2045, 2047, 2049, 2051, 2053, 2055, 2057, 2059, 2061,
2063, 2065, 2067, 2069, 2071, 2073, 2075, 2077, 2079, 2081, 2083, 2085, 2087, 2089, 2091,
2093, 2095, 2097, 2099, 2101, 2103, 2105, 2107, 2109, 2111, 2113, 2115, 2117, 2119, 2121,
2123, 2125, 2127, 2129, 2131, 2133, 2135, 2137, 2139, 2141, 2143, 2145, 2147, 2149, 2151,

2158, 2159, 2161, 2163, 2165, 2167, 2169, 2171, 2173, 2175, 2177, 2179, 2181, 2183, 2185, 2187, 2189, 2191, 2193, 2195, 2197, 2199, 2201, 2203, 2205, 2207, 2209, 2211, 2213, 2215, 2217, 2219, 2221, 2223, 2225, 2227, 2229, 2231, 2233, 2235, 2237, 2239, 2241, 2243, 2245, 2247, 2249, 2251, 2253, 2255, 2257, 2259, 2261, 2263, 2265, 2267, 2269, 2271, 2273, 2275, 2277, 2279, 2281, 2283, 2285, 2287, 2289, 2291, 2293, 2295, 2297, 2299, 2301, 2303, 2305, 2307, 2309, 2311, 2313, 2315, 2317, 2319, 2321, 2323, 2325, 2327, 2329, 2331, 2333, 2335, 2337, 2339, 2341, 2343, 2345, 2347, 2349, 2351, 2353, 2355, 2357, 2359, 2361, 2363, 2365, 2367, 2369, 2371, 2373, 2375, 2377, 2379, 2381, 2383, 2385, 2387, 2389, 2391, 2393, 2395, 2397, 2399, 2401, 2403, 2405, 2407, 2409, 2411, 2413, 2415, 2417, 2419, 2421, 2423, 2425, 2427, 2429, 2431, 2433, 2435, 2437, 2439, 2441, 2443, 2445, 2447, 2449, 2451, 2453, 2455, 2457, 2459, 2461, 2463, 2465, 2467, 2469, 2471, 2473, 2475, 2477, 2479, 2481, 2483, 2485, 2487, 2489, 2491, 2493, 2495, 2497, 2499, 2501, 2503, 2505, 2507, 2509, 2511, 2513, 2515, 2517, 2519, 2521, 2523, 2525, 2527, 2529, 2531, 2533, 2535, 2537, 2539, 2541, 2543, 2545, 2547, 2549, 2551, 2553, 2555, 2557, 2559, 2561, 2563, 2565, 2567, 2569, 2571, 2573, 2575, 2577, 2579, 2581, 2583, 2585, 2587, 2589, 2591, 2593, 2595, 2597, 2599, 2601, 2603, 2605, 2607, 2609, 2611, 2613, 2615, 2617, 2619, 2621, 2623, 2625, 2627, 2629, 2631, 2633, 2635, 2637, 2639, 2641, 2643, 2645, 2647, 2649, 2651, 2653, 2655, 2657, 2659, 2661, 2663, 2665, 2667, 2669, 2671, 2673, 2675, 2677, 2679, 2681, 2683, 2685, 2687, 2689, 2691, 2693, 2695, 2697, 2699, 2701, 2703, 2705, 2707, 2709, 2711, 2713, 2715, 2717, 2719, 2721, 2723, 2725, 2727, 2729, 2731, 2733, 2735, 2737, 2739, 2741, 2743, 2745, 2747, 2749, 2751, 2753, 2755, 2757, 2759, 2761, 2763, 2765, 2767, 2769, 2771, 2773, 2775, 2777, 2779, 2781, 2783, 2785, 2787, 2789, 2791, 2793, 2795, 2797, 2799, 2801, 2803, 2805, 2807, 2809, 2811, 2813, 2815, 2817, 2819, 2821, 2823, 2825, 2827, 2829, 2831, 2833, 2835, 2837, 2839, 2841, 2843, 2845, 2847, 2849, 2851, 2853, 2855, 2857, 2859, 2861, 2863, 2865, 2867, 2869, 2871, 2873, 2875, 2877, 2879, 2881, 2883, 2885, 2887, 2889, 2891, 2893, 2895, 2897, 2899, 2901, 2903, 2905, 2907, 2909, 2911, 2913, 2915, 2917, 2919, 2921, 2923, 2925, 2927, 2929, 2931, 2933, 2935, 2937, 2939, 2941, 2943, 2945, 2947, 2949, 2951, 2953, 2955, 2957, 2959, 2961, 2963, 2965, 2967, 2969, 2971, 2973, 2975, 2977, 2979, 2981, 2983, 2985, 2987, 2989, 2991, 2993, 2995, 2997, 2999, 3001, 3003, 3005, 3007, 3009, 3011, 3013, 3015, 3017, 3019, 3021, 3023, 3025, 3027, 3029, 3031, 3033, 3035, 3037, 3039, 3041, 3043, 3045, 3047, 3049, 3051, 3053, 3055, 3057, 3059, 3061, 3063, 3065, 3067, 3069, 3071, 3073, 3075, 3077, 3079, 3081, 3083, 3085, 3087, 3089, 3091, 3093, 3095, 3097, 3099, 3101, 3103, 3105, 3107, 3109, 3111, 3113, 3115, 3117, 3119, 3121, 3123, 3125, 3127, 3129, 3131, 3133, 3135, 3137, 3139, 3141, 3143, 3145, 3147, 3149, 3151, 3153, 3155, 3157, 3159, 3161, 3163, 3165, 3167, 3169, 3171, 3173, 3175, 3177, 3179, 3181, 3183, 3185, 3187, 3189, 3191, 3193, 3195, 3197, 3199, 3201, 3203, 3205, 3207, 3209, 3211, 3213, 3215, 3217, 3219, 3221, 3223, 3225, 3227, 3229, 3231, 3233, 3235, 3237, 3239, 3241, 3243, 3245, 3247, 3249, 3251, 3253, 3255, 3257, 3259, 3261, 3263, 3265, 3267, 3269, 3271, 3273, 3275, 3277, 3279, 3281, 3283, 3285, 3287, 3289, 3291,

CT 3293, 3295, 3297, 3299, 3301, 3303, 3305, 3307, 3309, 3311, 3313, 3315, 3317, 3319, 3321, 3323, 3325, 3327, 3329, 3331, 3333, 3335, 3337, 3339, 3341, 3343, 3345, 3347, 3349, 3351, 3353, 3355, 3357, 3359, 3361, 3363, 3365, 3367, 3369, 3371, 3373, 3375, 3377, 3379, 3381, 3383, 3385, 3387, 3389, 3391, 3393, 3395, 3397, 3399, 3401, 3403, 3405, 3407, 3409, 3411, 3413, 3415, 3417, 3419, 3421, 3423, 3425, 3427, 3429, 3431, 3433, 3435, 3437, 3439, 3441, 3443, 3445, 3447, 3449, 3451, 3453, 3455, 3457, 3459, 3461, 3463, 3465, 3467, 3469, 3471, 3473, 3475, 3477, 3479, 3481, 3483, 3485, 3487, 3489, 3491, 3493, 3495, 3497, 3499, 3501, 3503, 3505, 3507, 3509, 3511, 3513, 3515, 3517, 3519, 3521, 3523, 3525, 3527, 3529, 3531, 3533, 3535, 3537, 3539, 3541, 3543, 3545, 3547, 3549, 3551, 3553, 3555, 3557, 3559, 3561, 3563, 3565, 3567, 3569, 3571, 3573, 3575, 3577, 3579, 3581, 3583, 3585, 3587, 3589, 3591, 3593, 3595, 3597, 3599, 3601, 3603, 3605, 3607, 3609, 3611, 3613, 3615, 3617, 3619, 3621, 3623, 3625, 3627, 3629, 3631, 3633, 3635, 3637, 3639, 3641, 3643, 3645, 3647, 3649, 3651, 3653, 3655, 3657, 3659, 3661, 3663, 3665, 3667, 3669, 3671, 3673, 3675, 3677, 3679, 3681, 3683, 3685, 3687, 3689, 3691, 3693, 3695, 3697, 3699, 3701, 3703, 3705, 3707, 3709, 3711, 3713, 3715, 3717, 3719, 3721, 3723, 3725, 3727, 3729, 3731, 3733, 3735, 3737, 3739, 3741, 3743, 3745, 3747, 3749, 3751, 3753, 3755, 3757, 3759, 3761, 3763, 3765, 3767, 3769, 3771, 3773, 3775, 3777, 3779, 3781, 3783, 3785, 3787, 3789, 3791, 3793, 3795, 3797, 3799, 3801, 3803, 3805, 3807, 3809, 3811, 3813, 3815, 3817, 3819, 3821, 3823, 3825, 3827, 3829, 3831, 3833, 3835, 3837, 3839, 3841, 3843, 3845, 3847, 3849, 3851, 3853, 3855, 3857, 3859, 3861, 3863, 3865, 3867, 3869, 3871, 3873, 3875, 3877, 3879, 3881, 3883, 3885, 3887, 3889, 3891, 3893, 3895, 3897, 3899, 3901, 3903, 3905, 3907, 3909, 3911, 3913, 3915, 3917, 3919, 3921, 3923, 3925, 3927, 3929, 3931, 3933, 3935, 3937, 3939, 3941, 3943, 3945, 3947, 3949, 3951, 3953, 3955, 3957, 3959, 3961, 3963, 3965, 3967, 3969, 3971, 3973, 3975, 3977, 3979, 3981, 3983, 3985, 3987, 3989, 3991, 3993, 3995, 3997, 3999, 4001, 4003, 4005, 4007, 4009, 4011, 4013, 4015, 4017, 4019, 4021, 4023, 4025, 4027, 4029, 4031, 4033, 4035, 4037, 4039, 4041, 4043, 4045, 4047, 4049, 4051, 4053, 4055, 4057, 4059, 4061, 4063, 4065, 4067, 4069, 4071, 4073, 4075, 4077, 4079, 4081, 4083, 4085, 4087, 4089, 4091, 4093, 4095, 4097, 4099, 4101, 4103, 4105, 4107, 4109, 4111, 4113, 4115, 4117, 4119, 4121, 4123, 4125, 4127, 4129, 4131, 4133, 4135, 4137, 4139, 4141, 4143, 4145, 4147, 4149, 4151, 4153, 4155, 4157, 4159, 4161, 4163, 4165, 4167, 4169, 4171, 4173, 4175, 4177, 4179, 4181, 4183, 4185, 4187, 4189, 4191, 4193, 4195, 4197, 4199, 4201, 4203, 4205, 4207, 4209, 4211, 4213, 4215, 4217, 4219, 4221, 4223, 4225, 4227, 4229, 4231, 4233, 4235, 4237, 4239, 4241, 4243, 4245, 4247, 4249, 4251, 4253, 4255, 4257, 4259, 4261, 4263, 4265, 4267, 4269, 4271, 4273, 4275, 4277, 4279, 4281, 4283, 4285, 4287, 4289, 4291, 4293, 4295, 4297, 4299, 4301, 4303, 4305, 4307, 4309, 4311, 4313, 4315, 4317, 4319, 4321, 4323, 4325, 4327, 4329, 4331, 4333, 4335, 4337, 4339, 4341, 4343, 4345, 4347, 4349, 4351, 4353, 4355, 4357, 4359, 4361, 4363, 4365, 4367, 4369, 4371, 4373, 4375, 4377, 4379, 4381, 4383, 4385, 4387, 4389, 4391, 4393, 4395, 4397, 4399, 4401, 4403, 4405, 4407, 4409, 4411, 4413, 4415, 4417, 4419, 4421, 4423, 4425, 4427, 4429, 4431,

4433, 4435, 4437, 4439, 4441, 4443, 4445, 4447, 4449, 4451, 4453, 4455, 4457, 4459, 4461, 4463, 4465, 4467, 4469, 4471, 4473, 4475, 4477, 4479, 4481, 4483, 4485, 4487, 4489, 4491, 4493, 4495, 4497, 4499, 4501, 4503, 4505, 4507, 4509, 4511, 4513, 4515, 4517, 4519, 4521, 4523, 4525, 4527, 4529, 4531, 4533, 4535, 4537, 4539, 4541, 4543, 4545, 4547, 4549, 4551, 4553, 4555, 4557, 4559, 4561, 4563, 4565, 4567, 4569, 4571, 4573, 4575, 4577, 4579, 4581, 4583, 4585, 4587, 4589, 4591, 4593, 4595, 4597, 4599, 4601, 4603, 4605, 4607, 4609, 4611, 4613, 4615, 4617, 4619, 4621, 4623, 4625, 4627, 4629, 4631, 4633, 4635, 4637, 4639, 4641, 4643, 4645, 4647, 4649, 4651, 4653, 4655, 4657, 4659, 4661, 4663, 4665, 4667, 4669, 4671, 4673, 4675, 4677, 4679, 4681, 4683, 4685, 4687, 4689, 4691, 4693, 4695, 4697, 4699, 4701, 4703, 4705, 4707, 4709, 4711, 4713, 4715, 4717, 4719, 4721, 4723, 4725, 4727, 4729, 4731, 4733, 4735, 4737, 4739, 4741, 4743, 4745, 4747, 4749, 4751, 4753, 4755, 4757, 4759, 4761, 4763, 4765, 4767, 4769, 4771, 4773, 4775, 4777, 4779, 4781, 4783, 4785, 4787, 4789, 4791, 4793, 4795, 4797, 4799, 4801, 4803, 4805, 4807, 4809, 4811, 4813, 4815, 4817, 4819, 4821, 4823, 4825, 4827, 4829, 4831, 4833, 4835, 4837, 4839, 4841, 4843, 4845, 4847, 4849, 4851, 4853, 4855, 4857, 4859, 4861, 4863, 4865, 4867, 4869, 4871, 4873, 4875, 4877, 4879, 4881, 4883, 4885, 4887, 4889, 4891, 4893, 4895, 4897, 4899, 4901, 4903, 4905, 4907, 4909, 4911, 4913, 4915, 4917, 4919, 4921, 4923, 4925, 4927, 4929, 4931, 4933, 4935, 4937, 4939, 4941, 4943, 4945, 4947, 4949, 4951, 4953, 4955, 4957, 4959, 4961, 4963, 4965, 4967, 4969, 4971, 4973, 4975, 4977, 4979, 4981, 4983, 4985, 4987, 4989, 4991, 4993, 4995, 4997, 4999, 5001, 5003, 5005, 5007, 5009, 5011, 5013, 5015, 5017, 5019, 5021, 5023, 5025, 5027, 5029, 5031, 5033, 5035, 5037, 5039, 5041, 5043, 5045, 5047, 5049, 5051, 5053, 5055, 5057, 5059, 5061, 5063, 5065, 5067, 5069, 5071, 5073, 5075, 5077, 5079, 5081, 5083, 5085, 5087, 5089, 5091, 5093, 5095, 5097, 5099, 5101, 5103, 5105, 5107, 5109, 5111, 5113, 5115, 5117, 5119, 5121, 5123, 5125, 5127, 5129, 5131, 5133, 5135, 5137, 5139, 5141, 5143, 5145, 5147, 5149, 5151, 5153, 5155, 5157, 5159, 5161, 5163, 5165, 5167, 5169, 5171, 5173, 5175, 5177, 5179, 5181, 5183, 5185, 5187, 5189, 5191, 5193, 5195, 5197, 5199, 5201, 5203, 5205, 5207, 5209, 5211, 5213, 5215, 5217, 5219, 5221, 5223, 5225, 5227, 5229, 5231, 5233, 5235, 5237, 5239, 5241, 5243, 5245, 5247, 5249, 5251, 5253, 5255, 5257, 5259, 5261, 5263, 5265, 5267, 5269, 5271, 5273, 5275, 5277, 5279, 5281, 5283, 5285, 5287, 5289, 5291, 5293, 5295, 5297, 5299, 5301, 5303, 5305, 5307, 5309, 5311, 5313, 5315, 5317, 5319, 5321, 5323, 5325, 5327, 5329, 5331, 5333, 5335, 5337, 5339, 5341, 5343, 5345, 5347, 5349, 5351, 5353, 5355, 5357, 5359, 5361, 5363, 5365, 5367, 5369, 5371, 5373, 5375, 5377, 5379, 5381, 5383, 5385, 5387, 5389, 5391, 5393, 5395, 5397, 5399, 5401, 5403, 5405, 5407, 5409, 5411, 5413, 5415, 5417, 5419, 5421, 5423, 5425, 5427, 5429, 5431, 5433, 5435, 5437, 5439, 5441, 5443, 5445, 5447, 5449, 5451, 5453, 5455, 5457, 5459, 5461, 5463, 5465, 5467, 5469, 5471, 5473, 5475, 5477, 5479, 5481, 5483, 5485, 5487, 5489, 5491, 5493, 5495, 5497, 5499, 5501, 5503, 5505, 5507, 5509, 5511, 5513, 5515, 5517, 5519, 5521, 5523, 5525, 5527, 5529, 5531, 5533, 5535, 5537, 5539, 5541, 5543, 5545, 5547, 5549, 5551, 5553, 5555, 5557, 5559, 5561, 5563, 5565, 5567, 5569, 5571,

5573, 5575, 5577, 5579, 5581, 5583, 5585, 5587, 5589, 5591, 5593, 5595, 5597, 5599, 5601, 5603, 5605, 5607, 5609, 5611, 5613, 5615, 5617, 5619, 5621, 5623, 5625, 5627, 5629, 5631, 5633, 5635, 5637, 5639, 5641, 5643, 5645, 5647, 5649, 5651, 5653, 5655, 5657, 5659, 5661, 5663, 5665, 5667, 5669, 5671, 5673, 5675, 5677, 5679, 5681, 5683, 5685, 5687, 5689, 5691, 5693, 5695, 5697, 5699, 5701, 5703, 5705, 5707, 5709, 5711, 5713, 5715, 5717, 5719, 5721, 5723, 5725, 5727, 5729, 5731, 5733, 5735, 5737, 5739, 5741, 5743, 5745, 5747, 5749, 5751, 5753, 5755, 5757, 5759, 5761, 5763, 5765, 5767, 5769, 5771, 5773, 5775, 5777, 5779, 5781, 5783, 5785, 5787, 5789, 5791, 5793, 5795, 5797, 5799, 5801, 5803, 5805, 5807, 5809, 5811, 5813, 5815, 5817, 5819, 5821, 5823, 5825, 5827, 5829, 5831, 5833, 5835, 5837, 5839, 5841, 5843, 5845, 5847, 5849, 5851, 5853, 5855, 5857, 5859, 5861, 5863, 5865, 5867, 5869, 5871, 5873, 5875, 5877, 5879, 5881, 5883, 5885, 5887, 5889, 5891, 5893, 5895, 5897, 5899, 5901, 5903, 5905, 5907, 5909, 5911, 5913, 5915, 5917, 5919, 5921, 5923, 5925, 5927, 5929, 5931, 5933, 5935, 5937, 5939, 5941, 5943, 5945, 5947, 5949, 5951, 5953, 5955, 5957, 5959, 5961, 5963, 5965, 5967, 5969, 5971, 5973, 5975, 5977, 5979, 5981, 5983, 5985, 5987, 5989, 5991, 5993, 5995, 5997, 5999, 6001, 6003, 6005, 6007, 6009, 6011, 6013, 6015, 6017, 6019, 6021, 6023, 6025, 6027, 6029, 6031, 6033, 6035, 6037, 6039, 6041, 6043, 6045, 6047, 6049, 6051, 6053, 6055, 6057, 6059, 6061, 6063, 6065, 6067, 6069, 6071, 6073, 6075, 6077, 6079, 6081, 6083, 6085, 6087, 6089, 6091, 6093, 6095, 6097, 6099, 6101, 6103, 6105, 6107, 6109, 6111, 6113, 6115, 6117, 6119, 6121, 6123, 6125, 6127, 6129, 6131, 6133, 6135, 6137, 6139, 6141, 6143, 6145, 6147, 6149, 6151, 6153, 6155, 6157, 6159, 6161, 6163, 6165, 6167, 6169, 6171, 6173, 6175, 6177, 6179, 6181, 6183, 6185, 6187, 6189, 6191, 6193, 6195, 6197, 6199, 6201, 6203, 6205, 6207, 6209, 6211, 6213, 6215, 6217, 6219, 6221, 6223, 6225, 6227, 6229, 6231, 6233, 6235, 6237, 6239, 6241, 6243, 6245, 6247, 6249, 6251, 6253, 6255, 6257, 6259, 6261, 6263, 6265, 6267, 6269, 6271, 6273, 6275, 6277, 6279, 6281, 6283, 6285, 6287, 6289, 6291, 6293, 6295, 6297, 6299, 6301, 6303, 6305, 6307, 6309, 6311, 6313, 6315, 6317, 6319, 6321, 6323, 6325, 6327, 6329, 6331, 6333, 6335, 6337, 6339, 6341, 6343, 6345, 6347, 6349, 6351, 6353, 6355, 6357, 6359, 6361, 6363, 6365, 6367, 6369, 6371, 6373, 6375, 6377, 6379, 6381, 6383, 6385, 6387, 6389, 6391, 6393, 6395, 6397, 6399, 6401, 6403, 6405, 6407, 6409, 6411, 6413, 6415, 6417, 6419, 6421, 6423, 6425, 6427, 6429, 6431, 6433, 6435, 6437, 6439, 6441, 6443, 6445, 6447, 6449, 6451, 6453, 6455, 6457, 6459, 6461, 6463, 6465, 6467, 6469, 6471, 6473, 6475, 6477, 6479, 6481, 6483, 6485, 6487, 6489, 6491, 6493, 6495, 6497, 6499, 6501, 6503, 6505, 6507, 6509, 6511, 6513, 6515, 6517, 6519, 6521, 6523, 6525, 6527, 6529, 6531, 6533, 6535, 6537, 6539, 6541, 6543, 6545, 6547, 6549, 6551, 6553, 6555, 6557, 6559, 6561, 6563, 6565, 6567, 6569, 6571, 6573, 6575, 6577, 6579, 6581, 6583, 6585, 6587, 6589, 6591, 6593, 6595, 6597, 6599, 6601, 6603, 6605, 6607, 6609, 6611, 6613, 6615, 6617, 6619, 6621, 6623, 6625, 6627, 6629, 6631, 6633, 6635, 6637, 6639, 6641, 6643, 6645, 6647, 6649, 6651, 6653, 6655, 6657, 6659, 6661, 6663, 6665, 6667, 6669, 6671, 6673, 6675, 6677, 6679, 6681, 6683, 6685, 6687, 6689, 6691, 6693, 6695, 6697, 6699, 6701, 6703, 6705, 6707, 6709, 6711,

T 6713, 6715, 6717, 6719, 6721, 6723, 6725, 6727, 6729, 6731, 6733, 6735, 6737, 6739, 6741, 6743, 6745, 6747, 6749, 6751, 6753, 6755, 6757, 6759, 6761, 6763, 6765, 6767, 6769, 6771, 6773, 6775, 6777, 6779, 6781, 6783, 6785, 6787, 6789, 6791, 6793, 6795, 6797, 6799, 6801, 6803, 6805, 6807, 6809, 6811, 6813, 6815, 6817, 6819, 6821, 6823, 6825, 6827, 6829, 6831, 6833, 6835, 6837, 6839, 6841, 6843, 6845, 6847, 6849, 6851, 6853, 6855, 6857, 6859, 6861, 6863, 6865, 6867, 6869, 6871, 6873, 6875, 6877, 6879, 6881, 6883, 6885, 6887, 6889, 6891, 6893, 6895, 6897, 6899, 6901, 6903, 6905, 6907, 6909, 6911, 6913, 6915, 6917, 6919, 6921, 6923, 6925, 6927, 6929, 6931, 6933, 6935, 6937, 6939, 6941, 6943, 6945, 6947, 6949, 6951, 6953, 6955, 6957, 6959, 6961, 6963, 6965, 6967, 6969, 6971, 6973, 6975, 6977, 6979, 6981, 6983, 6985, 6987, 6989, 6991, 6993, 6995, 6997, 6999, 7001, 7003, 7005, 7007, 7009, 7011, 7013, 7015, 7017, 7019, 7021, 7023, 7025, 7027, 7029, 7031, 7033, 7035, 7037, 7039, 7041, 7043, 7045, 7047, 7049, 7051, 7053, 7055, 7057, 7059, 7061, 7063, 7065, 7067, 7069, 7071, 7073, 7075, 7077, 7079, 7081, 7083, 7085, 7087, 7089, 7091, 7093, 7095, 7097, 7099, 7101, 7103, 7105, 7107, 7109, 7111, 7113, 7115, 7117, 7119, 7121, 7123, 7125, 7127, 7129, 7131, 7133, 7135, 7137, 7139, 7141, 7143, 7145, 7147, 7149, 7151, 7153, 7155, 7157, 7159, 7161, 7163, 7165, 7167, 7169, 7171, 7173, 7175, 7177, 7179, 7181, 7183, 7185, 7187, 7189, 7191, 7193, 7195, 7197, 7199, 7201, 7203, 7205, 7207, 7209, 7211, 7213, 7215, 7217, 7219, 7221, 7223, 7225, 7227, 7229, 7231, 7233, 7235, 7237, 7239, 7241, 7243, 7245, 7247, 7249, 7251, 7253, 7255, 7257, 7259, 7261, 7263, 7265, 7267, 7269, 7271, 7273, 7275, 7277, 7279, 7281, 7283, 7285, 7287, 7289, 7291, 7293, 7295, 7297, 7299, 7301, 7303, 7305, 7307, 7309, 7311, 7313, 7315, 7317, 7319, 7321, 7323, 7325, 7327, 7329, 7331, 7333, 7335, 7337, 7339, 7341, 7343, 7345, 7347, 7349, 7351, 7353, 7355, 7357, 7359, 7361, 7363, 7365, 7367, 7369, 7371, 7373, 7375, 7377, 7379, 7381, 7383, 7385, 7387, 7389, 7391, 7393, 7395, 7397, 7399, 7401, 7403, 7405, 7407, 7409, 7411, 7413, 7415, 7417, 7419, 7421, 7423, 7425, 7427, 7429, 7431, 7433, 7435, 7437, 7439, 7441, 7443, 7445, 7447, 7449, 7451, 7453, 7455, 7457, 7459, 7461, 7463, 7465, 7467, 7469, 7471, 7473, 7475, 7477, 7479, 7481, 7483, 7485, 7487, 7489, 7491, 7493, 7495, 7497, 7499, 7501, 7503, 7505, 7507, 7509, 7511, 7513, 7515, 7517, 7519, 7521, 7523, 7525, 7527, 7529, 7531, 7533, 7535, 7537, 7539, 7541, 7543, 7545, 7547, 7549, 7551, 7553, 7555, 7557, 7559, 7561, 7563, 7565, 7567, 7569, 7571, 7573, 7575, 7577, 7579, 7581, 7583, 7585, 7587, 7589, 7591, 7593, 7595, 7597, 7599, 7601, 7603, 7605, 7607, 7609, 7611, 7613, 7615, 7617, 7619, 7621, 7623, 7625, 7627, 7629, 7631, 7633, 7635, 7637, 7639, 7641, 7643, 7645, 7647, 7649, 7651, 7653, 7655, 7657, 7659, 7661, 7663, 7665, 7667, 7669, 7671, 7673, 7675, 7677, 7679, 7681, 7683, 7685, 7687, 7689, 7691, 7693, 7695, 7697, 7699, 7701, 7703, 7705, 7707, 7709, 7711, 7713, 7715, 7717, 7719, 7721, 7723, 7725, 7727, 7729, 7731, 7733, 7735, 7737, 7739, 7741, 7743, 7745, 7747, 7749, 7751, 7753, 7755, 7757, 7759, 7761, 7763, 7765, 7767, 7769, 7771, 7773, 7775, 7777, 7779, 7781, 7783, 7785, 7787, 7789, 7791, 7793, 7795, 7797, 7799, 7801, 7803, 7805, 7807, 7809, 7811, 7813, 7815, 7817, 7819, 7821, 7823, 7825, 7827, 7829, 7831, 7833, 7835, 7837, 7839, 7841, 7843, 7845, 7847, 7849, 7851,

7853, 7855, 7857, 7859, 7861, 7863, 7865, 7867, 7869, 7871, 7873, 7875, 7877, 7879, 7881, 7883, 7885, 7887, 7889, 7891, 7893, 7895, 7897, 7899, 7901, 7903, 7905, 7907, 7909, 7911, 7913, 7915, 7917, 7919, 7921, 7923, 7925, 7927, 7929, 7931, 7933, 7935, 7937, 7939, 7941, 7943, 7945, 7947, 7949, 7951, 7953, 7955, 7957, 7959, 7961, 7963, 7965, 7967, 7969, 7971, 7973, 7975, 7977, 7979, 7981, 7983, 7985, 7987, 7989, 7991, 7993, 7995, 7997, 7999, 8001, 8003, 8005, 8007, 8009, 8011, 8013, 8015, 8017, 8019, 8021, 8023, 8025, 8027, 8029, 8031, 8033, 8035, 8037, 8039, 8041, 8043, 8045, 8047, 8049, 8051, 8053, 8055, 8057, 8059, 8061, 8063, 8065, 8067, 8069, 8071, 8073, 8075, 8077, 8079, 8081, 8083, 8085, 8087, 8089, 8091, 8093, 8095, 8097, 8099, 8101, 8103, 8105, 8107, 8109, 8111, 8113, 8115, 8117, 8119, 8121, 8123, 8125, 8127, 8129, 8131, 8133, 8135, 8137, 8139, 8141, 8143, 8145, 8147, 8149, 8151, 8153, 8155, 8157, 8159, 8161, 8163, 8165, 8167, 8169, 8171, 8173, 8175, 8177, 8179, 8181, 8183, 8185, 8187, 8189, 8191, 8193, 8195, 8197, 8199, 8201, 8203, 8205, 8207, 8209, 8211, 8213, 8215, 8217, 8219, 8221, 8223, 8225, 8227, 8229, 8231, 8233, 8235, 8237, 8239, 8241, 8243, 8245, 8247, 8249, 8251, 8253, 8255, 8257, 8259, 8261, 8263, 8265, 8267, 8269, 8271, 8273, 8275, 8277, 8279, 8281, 8283, 8285, 8287, 8289, 8291, 8293, 8295, 8297, 8299, 8301, 8303, 8305, 8307, 8309, 8311, 8313, 8315, 8317, 8319, 8321, 8323, 8325, 8327, 8329, 8331, 8333, 8335, 8337, 8339, 8341, 8343, 8345, 8347, 8349, 8351, 8353, 8355, 8357, 8359, 8361, 8363, 8365, 8367, 8369, 8371, 8373, 8375, 8377, 8379, 8381, 8383, 8385, 8387, 8389, 8391, 8393, 8395, 8397, 8399, 8401, 8403, 8405, 8407, 8409, 8411, 8413, 8415, 8417, 8419, 8421, 8423, 8425, 8427, 8429, 8431, 8433, 8435, 8437, 8439, 8441, 8443, 8445, 8447, 8449, 8451, 8453, 8455, 8457, 8459, 8461, 8463, 8465, 8467, 8469, 8471, 8473, 8475, 8477, 8479, 8481, 8483, 8485, 8487, 8489, 8491, 8493, 8495, 8497, 8499, 8501, 8503, 8505, 8507, 8509, 8511, 8513, 8515, 8517, 8519, 8521, 8523, 8525, 8527, 8529, 8531, 8533, 8535, 8537, 8539, 8541, 8543, 8545, 8547, 8549, 8551, 8553, 8555, 8557, 8559, 8561, 8563, 8565, 8567, 8569, 8571, 8573, 8575, 8577, 8579, 8581, 8583, 8585, 8587, 8589, 8591, 8593, 8595, 8597, 8599, 8601, 8603, 8605, 8607, 8609, 8611, 8613, 8615, 8617, 8619, 8621, 8623, 8625, 8627, 8629, 8631, 8633, 8635, 8637, 8639, 8641, 8643, 8645, 8647, 8649, 8651, 8653, 8655, 8657, 8659, 8661, 8663, 8665, 8667, 8669, 8671, 8673, 8675, 8677, 8679, 8681, 8683, 8685, 8687, 8689, 8691, 8693, 8695, 8697, 8699, 8701, 8703, 8705, 8707, 8709, 8711, 8713, 8715, 8717, 8719, 8721, 8723, 8725, 8727, 8729, 8731, 8733, 8735, 8737, 8739, 8741, 8743, 8745, 8747, 8749, 8751, 8753, 8755, 8757, 8759, 8761, 8763, 8765, 8767, 8769, 8771, 8773, 8775, 8777, 8779, 8781, 8783, 8785, 8787, 8789, 8791, 8793, 8795, 8797, 8799, 8801, 8803, 8805, 8807, 8809, 8811, 8813, 8815, 8817, 8819, 8821, 8823, 8825, 8827, 8829, 8831, 8833, 8835, 8837, 8839, 8841, 8843, 8845, 8847, 8849, 8851, 8853, 8855, 8857, 8859, 8861, 8863, 8865, 8867, 8869, 8871, 8873, 8875, 8877, 8879, 8881, 8883, 8885, 8887, 8889, 8891, 8893, 8895, 8897, 8899, 8901, 8903, 8905, 8907, 8909, 8911, 8913, 8915, 8917, 8919, 8921, 8923, 8925, 8927, 8929, 8931, 8933, 8935, 8937, 8939, 8941, 8943, 8945, 8947, 8949, 8951, 8953, 8955, 8957, 8959, 8961, 8963, 8965, 8967, 8969, 8971, 8973, 8975, 8977, 8979, 8981, 8983, 8985, 8987, 8989, 8991,

8993, 8995, 8997, 8999, 9001, 9003, 9005, 9007, 9009, 9011, 9013, 9015, 9017, 9019, 9021, 9023, 9025, 9027, 9029, 9031, 9033, 9035, 9037, 9039, 9041, 9043, 9045, 9047, 9049, 9051, 9053, 9055, 9057, 9059, 9061, 9063, 9065, 9067, 9069, 9071, 9073, 9075, 9077, 9079, 9081, 9083, 9085, 9087, 9089, 9091, 9093, 9095, 9097, 9099, 9101, 9103, 9105, 9107, 9109, 9111, 9113, 9115, 9117, 9119, 9121, 9123, 9125, 9127, 9129, 9131, 9133, 9135, 9137, 9139, 9141, 9143, 9145, 9147, 9149, 9151, 9153, 9155, 9157, 9159, 9161, 9163, 9165, 9167, 9169, 9171, 9173, 9175, 9177, 9179, 9181, 9183, 9185, 9187, 9189, 9191, 9193, 9195, 9197, 9199, 9201, 9203, 9205, 9207, 9209, 9211, 9213, 9215, 9217, 9219, 9221, 9223, 9225, 9227, 9229, 9231, 9233, 9235, 9237, 9239, 9241, 9243, 9245, 9247, 9249, 9251, 9253, 9255, 9257, 9259, 9261, 9263, 9265, 9267, 9269, 9271, 9273, 9275, 9277, 9279, 9281, 9283, 9285, 9287, 9289, 9291, 9293, 9295, 9297, 9299, 9301, 9303, 9305, 9307, 9309, 9311, 9313, 9315, 9317, 9319, 9321, 9323, 9325, 9327, 9329, 9331, 9333, 9335, 9337, 9339, 9341, 9343, 9345, 9347, 9349, 9351, 9353, 9355, 9357, 9359, 9361, 9363, 9365, 9367, 9369, 9371, 9373, 9375, 9377, 9379, 9381, 9383, 9385, 9387, 9389, 9391, 9393, 9395, 9397, 9399, 9401, 9403, 9405, 9407, 9409, 9411, 9413, 9415, 9417, 9419, 9421, 9423, 9425, 9427, 9429, 9431, 9433, 9435, 9437, 9439, 9441, 9443, 9445, 9447, 9449, 9451, 9453, 9455, 9457, 9459, 9461, 9463, 9465, 9467, 9469, 9471, 9473, 9475, 9477, 9479, 9481, 9483, 9485, 9487, 9489, 9491, 9493, 9495, 9497, 9499, 9501, 9503, 9505, 9507, 9509, 9511, 9513, 9515, 9517, 9519, 9521, 9523, 9525, 9527, 9529, 9531, 9533, 9535, 9537, 9539, 9541, 9543, 9545, 9547, 9549, 9551, 9553, 9555, 9557, 9559, 9561, 9563, 9565, 9567, 9569, 9571, 9573, 9575, 9577, 9579, 9581, 9583, 9585, 9587, 9589, 9591, 9593, 9595, 9597, 9599, 9601, 9603, 9605, 9607, 9609, 9611, 9613, 9615, 9617, 9619, 9621, 9623, 9625, 9627, 9629, 9631, 9633, 9635, 9637, 9639, 9641, 9643, 9645, 9647, 9649, 9651, 9653, 9655, 9657, 9659, 9661, 9663, 9665, 9667, 9669, 9671, 9673, 9675, 9677, 9679, 9681, 9683, 9685, 9687, 9689, 9691, 9693, 9695, 9697, 9699, 9701, 9703, 9705, 9707, 9709, 9711, 9713, 9715, 9717, 9719, 9721, 9723, 9725, 9727, 9729, 9731, 9733, 9735, 9737, 9739, 9741, 9743, 9745, 9747, 9749, 9751, 9753, 9755, 9757, 9759, 9761, 9763, 9765, 9767, 9769, 9771, 9773, 9775, 9777, 9779, 9781, 9783, 9785, 9787, 9789, 9791, 9793, 9795, 9797, 9799, 9801, 9803, 9805, 9807, 9809, 9811, 9813, 9815, 9817, 9819, 9821, 9823, 9825, 9827, 9829, 9831, 9833, 9835, 9837, 9839, 9841, 9843, 9845, 9847, 9849, 9851, 9853, 9855, 9857, 9859, 9861, 9863, 9865, 9867, 9869, 9871, 9873, 9875, 9877, 9879, 9881, 9883, 9885, 9887, 9889, 9891, 9893, 9895, 9897, 9899, 9901, 9903, 9905, 9907, 9909, 9911, 9913, 9915, 9917, 9919, 9921, 9923, 9925, 9927, 9929, 9931, 9933, 9935, 9937, 9939, 9941, 9943, 9945, 9947, 9949, 9951, 9953, 9955, 9957, 9959, 9961, 9963, 9965, 9967, 9969, 9971, 9973, 9975, 9977, 9979, 9981, 9983, 9985, 9987 and 9989; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

7. Nucleic acid according to claim 6, comprising: (a) a nucleotide sequence selected from the group consisting of SEQ ID NOs 511, 2453, 2455, 2677, 2691, 4595, 4747, 7003, 7051, 8167, 4627 and 5699; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

8. Nucleic acid according to claim 6, comprising: (a) a nucleotide sequence selected from the group consisting of SEQ ID Nos 8563, 2727, 9871, 4671, 5679, 533, 3221, 3225 and 7003; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

9. Nucleic acid according to any one of claims 6 to 8, encoding the polypeptide of claim 1, claim 2, claim 3 or claim 4.

10. A monoclonal antibody specific for the polypeptide of any one of claims 1 to 4.

11. A pharmaceutical composition comprising the polypeptide of claim 1 to 4, the nucleic acid of claim 1 to 9, or the antibody of claim 10, in admixture with a pharmaceutically acceptable carrier.

12. A pharmaceutical composition comprising two or more polypeptides of claims 1 to 4, in admixture with a pharmaceutically acceptable carrier.

13. The composition of claim 10 or claim 11, further comprising a vaccine adjuvant.

14. An immunogenic composition comprising one or more outer membrane vesicles (OMVs) expressing or overexpressing one or more polypeptides encoded by: (a) a nucleotide sequence selected from the group consisting of SEQ ID NOs 511, 2453, 2455, 2677, 2691, 4595, 4747, 7003, 7051, 8167, 4627 and 5699; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

15. An immunogenic composition comprising one or more outer membrane vesicles (OMVs) expressing or overexpressing one or more polypeptides encoded by: (a) a nucleotide sequence selected from the group consisting of SEQ ID Nos 8563, 2727, 9871, 4671, 5679, 533, 3221, 3225 and 7003; (b) a nucleotide sequence having at least 80% sequence identity to an amino acid sequence of (a); (c) a nucleotide sequence which is a fragment of at least 10 consecutive

nucleotides from a nucleotide sequence of (a); or (d) a nucleotide sequence having at least 80% sequence identity to a nucleotide sequence of (a) and including a fragment of at least 10 consecutive nucleotides from a nucleotide sequence of (a).

16. The immunogenic composition of claim 14 or claim 15, wherein said fragment comprises at least one B-cell epitope of (a).

17. Use of the polypeptide of claim 1 to 4, or the nucleic acid of claim 6 to 9, or the antibody of claim 10, or the immunogenic composition of claim 14 to 16, in the manufacture of a medicament for raising an immune response in a patient.

18. A method for raising an immune response in a patient, comprising the step of administering to the patient the pharmaceutical composition of any one of claims 10 to 12 or the immunogenic composition of any one of claims 14 to 16.

19. The use of claim 17, or the method of claim 18, wherein the immune response is protective against ExPEC infection, and in particular against a MNEC infection.