Clonal Genotype of *Geomyces destructans* among Bats with White Nose Syndrome, New York, USA

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The dispersal mechanism of *Geomyces destructans*, which causes geomycosis (white nose syndrome) in hibernating bats, remains unknown. Multiple gene genealogic analyses were conducted on 16 fungal isolates from diverse sites in New York during 2008–2010. The results are consistent with the clonal dispersal of a single *G. destructans* genotype.

eomycosis, or white nose syndrome, is a newly Grecognized fungal infection of hibernating bats. The etiologic agent, the psychrophilic fungus Geomyces destructans, was first recognized in caves and mines around Albany, New York, USA (1,2). The disease has spread rapidly in New York and other states in the northeastern United States. At least 1 affected bat species is predicted to face regional extinction in the near future (3). Much remains unknown about this fungus, including its ecology and geographic distribution. For example, although hibernacula are high on the list of suspected sites, where the bats acquire this infection is not known. Similarly, although strongly suspected, the role of humans and other animals in the dispersal of G. destructans and the effect of such dispersals in bat infections have not been confirmed. We recently showed that 6 G. destructans strains from sites near Albany were genetically similar (2), raising the possibility of a common source for the spread of this infection. Corollary to this observation and other opinions (3,4), the US Fish & Wildlife Service has made an administrative decision to bar human access to caves as a precautionary measure

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The Study

We applied multiple gene genealogic analyses in studying G. destructans isolates; this approach yields robust results that are easily reproduced by other laboratories (5). Sixteen G. destructans isolates recovered from infected bats during 2008-2010 were analyzed. These isolates originated from 7 counties in New York and an adjoining county in Vermont, all within a 500-mile radius (Table 1). The details of isolation and identification of G. destructans from bat samples have been described (2). One isolate of a closely related fungus G. pannorum M1372 (University of Alberta Mold Herbarium, Edmonton, Alberta, Canada) was included as a reference control. To generate molecular markers, 1 isolate, G. destructans (M1379), was grown in yeast extract peptone dextrose broth at 15°C, and high molecular weight genomic DNA was prepared according to Moller et al. (6). A cosmid DNA library was constructed by using pWEB kit (Epicenter Biotechnologies, Madison, WI, USA) by following protocols described elsewhere (7). One hundred cosmid clones, each with \approx 40-Kb DNA insert, were partially sequenced in both directions by using primers M13 and T7. The nucleotide sequences were assembled with Sequencher 4.6 (Gene Codes Corp., Ann Arbor, MI, USA) and BLAST (www.ncbi.nlm.nih.gov/ BLAST) homology searches identified 37 putative genes. Sequences of 10 genes, including open reading frames, 3' and/or 5' untranslated regions, and introns, were evaluated as potential markers for analyzing G. pannorum and G. destructans. Our screening approach indicated that 8 gene

| Table 1. | Geomyces destructa | ns isolates studied, New York, USA |
|----------|--------------------|------------------------------------|
| Isolate | Date obtained | Site, county* |
| M1379† | 2008 Mar 28 | Williams Hotel Mine, Ulster |
| M1380† | 2008 Mar 28 | Williams Hotel Mine, Ulster |
| M1381† | 2008 Mar 28 | Williams Hotel Mine, Ulster |
| M1383† | 2008 Apr 11 | Graphite Mine, Warren |
| M2325 | 2010 Jan 25 | Westchester |
| M2327 | 2010 Feb 2 | Dewitt, Onondaga |
| M2330 | 2009 Mar 5 | Lancaster, Erie |
| M2331 | 2009 Mar 9 | White Plains, Westchester |
| M2332 | 2009 Mar 11 | Dannemora, Clinton |
| M2333 | 2009 Mar 11 | Dannemora, Clinton |
| M2334 | 2009 Mar 12 | Newstead, Erie |
| M2335 | 2009 Mar 16 | Ithaca, Tompkins |
| M2336 | 2009 Oct 6 | Bridgewater Mine, Windsor, VT |
| M2337 | 2010 Feb 9 | Akron Mine, Erie |
| M2338 | 2010 Mar 4 | Hailes Cave, Albany |
| M2339 | 2010 Mar 11 | Letchworth Tunnel, Livingston |

*All locations in New York state except Bridgewater Mine, Windsor, Vermont.

[†]Previously analyzed by randomly amplified polymorphic DNA typing.

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targets could be amplified from both *G. destructans* and *G. pannorum* by PCR (Table 2).

To obtain DNA sequences from 1 G. pannorum and 16 G. destructans isolates, we prepared genomic DNA from mycelia grown in yeast extract peptone dextrose broth through conventional glass bead treatment and phenolchloroform extraction and then ethanol precipitation (7). AccuTaq LA DNA Polymerase (Sigma-Aldrich, St. Louis, MO, USA) was used for PCR: 3 min initial denaturation at 94°C, 35 amplification cycles with a 15-sec denaturation at 94°C, 30-sec annealing at 55°C, and 1-min extension at 68°C and a 5-min final extension at 68°C. PCR products were treated with ExoSAP-IT (USB Corp., Cleveland, OH, USA) before sequencing. Both strands of amplicons were sequenced by the same primers used for PCR amplification (Table 2). A database was created by using Microsoft Access (Microsoft, Redmond, WA, USA) to deposit and analyze the sequences. Nucleotide sequences were aligned with ClustalW version 1.4 (www.clustal.org) and edited with MacVector 7.1.1 software (Accelrys, San Diego, CA, USA). Phylogenetic analyses were done by using PAUP 4.0 (8) and MEGA 4 (9).

We cloned and sequenced ≈ 200 Kb of the *G*. *destructans* genome and identified genes involved in a variety of cellular processes and metabolic pathways (Table 2). DNA sequence typing by using 8 gene fragments showed that all 16 *G*. *destructans* isolates had identical nucleotide sequences at all 8 sequenced gene fragments but were distinct from *G*. *pannorum* sequences. A maximumparsimony tree generated from the 8 concatenated gene fragments indicated a single, clonal genotype for the 16 *G*. destructans strains (Figure 1). This consensus tree included 4,470 aligned nucleotides from all targeted gene sequences with 545 variable sites that separate the G. destructans clonal genotype from G. pannorum. Further analyses of the same concatenated gene fragments with exclusion of 50 insertions and deletions between G. destructans and G. pannorum yielded a tree with a shorter length (495 steps instead of 545 steps) but an identical topology (online Technical Appendix Figure 1, www.cdc.gov/EID/ content/17/7/1273-Techapp.pdf). This pattern remained unchanged when different phylogenetics models were used for analysis (online Technical Appendix Figure 2). The lack of polymorphism among the 16 G. destructans isolates was unlikely because of evolutionary constraint at the sequenced gene fragments. We found many synonymous and nonsynonymous substitutions in target genes among a diversity of fungal species, including between G. destructans and G. pannorum (10) (online Technical Appendix Figure 3).

Conclusions

Our finding of a single clonal genotype in *G. destructans* population fits well with the rapid spread of geomycosis in New York (Figure 2). Our sampling population covered both spatial and temporal dimensions, and the numbers of isolates analyzed were adequate in view of difficulties encountered in obtaining pure isolations of *G. destructans* (11). Although the affected New York sites are separated by sizable distances and include geographic barriers, a role for the natural dissemination of the fungus through air, soil, and water cannot be ruled out. Indeed, several fungi with

| Table 2. | Geomyces destructans and G. | <i>pannorum</i> target gen | e fragments used for multiple gene genealogic ar | nalyses, New York, USA |
|----------|------------------------------|----------------------------|--|-------------------------|
| | | Amplicon size/ | | G. destructans/G. |
| | Homology (GenBank | sequence used for | | <i>pannorum</i> GenBank |
| Gene* | accession no.) | comparison, bp | Primer sequence, $5' \rightarrow 3'^{\dagger}$ | accession nos. |
| ALR | Penicillium marneffei | 654/534 | V1905 (f): CGGAGTGAGATTTATGACGGC | HQ834314- |
| | (XP_002152078.1) | | V1904 (r): CGTCCATCCCAGACGTTCATC | HQ834329/HQ834330 |
| Bpntase | Glomerella graminicola | 921/745 | V1869 (f): TCAGACGGACTCGGAGGGCAAG | HQ834331- |
| | (EFQ33509.1) | | V1926 (r): TCGGTTACAGAGCCTCAGTCG | HQ834346/HQ834347 |
| DHC1 | Sordaria macrospora | 597/418 | V1906 (f): GGATGATTCGGTCACCAAACAG | HQ834348- |
| | (CBI53717.1) | | V1907 (r): ACAGCAAACACAGCGCTGCAAG | HQ834363/HQ834364 |
| GPHN | Ajellomyces capsulatus | 659/525 | V1918 (f): CACTATTACATCGCCAGGCTC | HQ834365- |
| | (EEH06836.1) | | V1919 (r): CTAAACGCAGGCACTGCCTC | HQ834380/HQ834381 |
| PCS | A. capsulatus | 920/749 | V1929 (f): AGGCTGCGATTGCTGAGTGC | HQ834382- |
| | (EEH08767.1) | | V1873 (r): CCTTATCCAGCTTTCCTTGGTC | HQ834397/HQ834398 |
| POB3 | Pyrenophora tritici-repentis | 653/417 | V1908 (f): CACAGTGGAGCAAGGCATCC | HQ834399- |
| | (XP_001937502.1) | | V1909 (r): ACATACCTAGGCGTCAAGTGC | HQ834414/HQ834415 |
| SRP72 | A. dermatitidis | 941/640 | V1927 (f): AAGGGAAGGTTGGAGAGACTC | HQ834416- |
| | (EEQ90678.1) | | V1895 (r): CAAGCAGCATTGTACGCCGTC | HQ834431/HQ834432 |
| VPS13 | Verticillium albo-atrum | 665/545 | V1922 (f): GAGACAACGCTTGTTTGCAAGG | HQ834433- |
| | (XP_003001174.1) | | V1923 (r): ACATGCGTCGTTCCAAGATCTG | HQ834448/HQ834449 |

*Genes: *ALR*, α-L-rhamnosidase; *Bpntase*, 3'(2'),5'-bisphosphate nucleotidase; *DHC1*, Dynein heavy chain; *GPHN*, Gephyrin, molybdenum cofactor biosynthesis protein; *PCS*, peroxisomal-coenzyme A synthetase; *POB3*, FACT complex subunit; *SRP72*, signal recognition particle protein 72; *VPS13*, vacuolar protein sorting-associated protein.

†f, forward; r, reverse.



Figure 1. Consensus maximum-parsimony tree derived from analyzing 8 concatenated gene fragments including a total of 4,470 aligned nucleotides by using PAUP* 4.0 (8). The number 545 on the branch indicates the total number of variable nucleotide positions (out of the 4,470 nt) separating *Geomyces pannorum* M1372 from the clonal genotype of *G. destructans* identified here. Fifty of the 545 variable sites correspond to insertions and deletions. Scale bar indicates number of nucleotide substitutions per site.

geographic distributions similar to that in our study have shown major genetic variation among strains (12,13). It is also possible that humans and/or animals contributed to the rapid clonal dispersal. In such a scenario, the diseased or asymptomatic bats might act as carriers of the fungus by their migration into new hibernation sites where new animals get infected and the dissemination cycle continues (4). Similarly, the likely roles played by humans and/or other animals in the transfer of the fungal propagules from an affected site to a clean one cannot be ruled out from our data.

Virulent clones of human and plant pathogenic fungi that spread rapidly among affected populations have been recognized with increasing frequency in recent years (12,14). However, other pathogens, such as the frog-killing fungus *Batrachochytrium dendrobatidis*, have emerged with both clonal and recombining populations (13). Our data do not eliminate the possibility that the *G. destructans* population undergoes recombination in nature. This process to generate genetic variability would require some form of sexual reproduction, which remains unknown in *G. destructans*. In addition, the fungus might have both asexual and sexual modes in its saprobic life elsewhere in nature, but it exists only in asexual mode on bats (15).

In conclusion, our data suggest that a single clonal genotype of *G. destructans* has spread among affected bats in New York. This finding might be helpful for the professionals involved in devising control measures. Many outstanding questions remain about the origin of *G. destructans*, its migration, and reproduction, all of which will require concerted efforts if we are to save bats from predicted extinction (3).



Figure 2. Collection sites in New York counties (A) are color-matched with respective *Geomyces destructans* isolates in maximum-parsimony tree based on nucleotide sequence of the VPS13 gene (B). The tree was constructed with MEGA4 (9) by using 450 nt and bootstrap test with 500 replicates. In addition to *G. destructans* and *G. pannorum*, fungi analyzed were *Ajellomyces capsulatus* (AAJI01000550.1), *Aspergillus clavatus* NRRL 1 (AAKD03000035.1), *Botryotinia fuckeliana* B05.10 (AAID01002173.1), *Coccidioides posadasii* C735 delta SOWgp (ACFW01000049.1), *Neurospora crassa* OR74A (AABX0200023.1), *Paracoccidioides brasiliensis* Pb01 (ABKH01000209.1), and *Penicillium marneffei* ATCC 18224 (ABAR0100009.1).

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Technical Appendix

| G. destructans M1379 |
|----------------------|
| G. destructans M1380 |
| G. destructans M1381 |
| G. destructans M1383 |
| G. destructans M2325 |
| G. destructans M2327 |
| G. destructans M2330 |
| G. destructans M2331 |
| G. destructans M2332 |
| G. destructans M2333 |
| G. destructans M2334 |
| G. destructans M2335 |
| G. destructans M2336 |
| G. destructans M2337 |
| G. destructans M2338 |
| G. destructans M2339 |
| G. pannorum M1372 |

Technical Appendix Figure 1. Maximum-parsimony tree derived from analyzing 8 concatenated gene fragments. A total of 4,470 aligned nucleotides were analyzed by using PAUP* 4.0 (8). The number 495 on the branch indicates the number of different nucleotides (out of the 4,470 nt) separating *Geomyces pannorum* M1372 from the clonal genotype of *G. destructans* identified here. Insertions and deletions are excluded from this tree. Scale bar indicates number of nucleotide substitutions per site.



10

| | ALR | G. destructans M1379 | Bpntase | G. destructans M1379 | DHC1 | G. destructans M1379 | GPHN | G. destructans M1379 |
|---|-----|---|---------|--|-------------|---|--------|--|
| | | G. destructans M1380 | | G. destructans M1380 | | G. destructans M1380 | | G. destructans M1380 |
| | | G. destructans M1381 | | G. destructans M1381 | | G. destructans M1381 | | G. destructans M1381 |
| | | G. destructans M1383 | | G. destructans M1383 | | G. destructans M1383 | | G. destructans M1383 |
| | | G. destructans M2325 | | G. destructans M2325 | | G. destructans M2325 | | G. destructans M2325 |
| | | G. destructans M2327 | | G. destructans M2327 | | G. destructans M2327 | | G. destructans M2327 |
| | | G. destructans M2330 | | G. destructans M2330 | | G. destructans M2330 | | G. destructans M2330 |
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| [| | G. destructans M2332 | | G. destructans M2332 | | G. destructans M2332 | | G. destructans M2332 |
| | | G. destructans M2333 | | G. destructans M2333 | | G. destructans M2333 | | G. destructans M2333 |
| | | G. destructans M2334 | | G. destructans M2334 | | G. destructans M2334 | | G. destructans M2334 |
| | | G. destructans M2335 | | G. destructans M2335 | | G. destructans M2335 | | G. destructans M2335 |
| | 81 | G. destructans M2336 | 49 | G. destructans M2336 | 27 | G. destructans M2336 | 94 | G. destructans M2336 |
| | | G. destructans M2337 | | G. destructans M2337 | | G. destructans M2337 | | G. destructans M2337 |
| | | G. destructans M2338 | | G. destructans M2338 | | G. destructans M2338 | | G. destructans M2338 |
| | | G. destructans M2339 | | G. destructans M2339 | | G. destructans M2339 | | G. destructans M2339 |
| l | | - G. pannorum M1372 | | G. pannorum M1372 | | G. pannorum M1372 | | G. pannorum M1372 |
| | 5 | | 1 | | 1 | | 5 | |
| | | | | | | | | |
| | PCS | G. destructans M1379 | POB3 | G. destructans M1379 | SRP72 | G. destructans M1379 | VPS13 | G. destructans M1379 |
| | PCS | G. destructans M1379 G. destructans M1380 | POB3 | G. destructans M1379 G. destructans M1380 | SRP72 | G. destructans M1379 G. destructans M1380 | VPS13 | G. destructans M1379 G. destructans M1380 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 | SRP72 | G. destructans M1379 G. destructans M1380 G. destructans M1381 | VP\$13 | G. destructans M1379 G. destructans M1380 G. destructans M1381 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 | SRP72 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 | VPS13 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 | SRP72 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 | VPS13 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M1383 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 | SRP72 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 | VPS13 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2320 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2320 | SRP72 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2327 | VPS13 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M1383 G. destructans M2327 G. destructans M2327 G. destructans M2330 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2330 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2331 | SRP72 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2330 | VPS13 | G. destructans M1379 G. destructans M1380 G. destructans M1380 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2331 |
| [| PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2331 G. destructans M2331 G. destructans M2332 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2331 G. destructans M2331 | SRP72 | G. destructans M1379 G. destructans M1379 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2320 G. destructans M2330 G. destructans M2331 G. destructans M2331 | VPS13 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1381 G. destructans M1383 G. destructans M2327 G. destructans M2320 G. destructans M2330 G. destructans M2331 G. destructans M2331 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2331 G. destructans M2332 G. destructans M2332 G. destructans M2333 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2331 G. destructans M2332 G. destructans M2332 G. destructans M2333 | SRP72 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2320 G. destructans M2323 G. destructans M2332 G. destructans M2332 | VPS13 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2327 G. destructans M2320 G. destructans M2330 G. destructans M2331 G. destructans M2332 G. destructans M2332 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1380 G. destructans M1381 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2331 G. destructans M2332 G. destructans M2332 G. destructans M2333 G. destructans M2333 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2333 | SRP72 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M2325 G. destructans M2327 G. destructans M2320 G. destructans M2323 G. destructans M2333 G. destructans M2333 G. destructans M2333 | VPS13 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M2325 G. destructans M2326 G. destructans M2330 G. destructans M2331 G. destructans M2332 G. destructans M2332 G. destructans M2333 G. destructans M2334 G. destructans M2334 |
| | PCS | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M1383 G. destructans M2325 G. destructans M2320 G. destructans M2331 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2334 G. destructans M2334 | P083 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2320 G. destructans M2330 G. destructans M2331 G. destructans M2333 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2334 | SRP72 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M2325 G. destructans M2327 G. destructans M2331 G. destructans M2332 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2334 | VPS13 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2332 G. destructans M2332 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2334 G. destructans M2334 G. destructans M2334 G. destructans M2335 |
| | PCS | G. destructans M1379 G. destructans M1389 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2325 G. destructans M2330 G. destructans M2331 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2334 G. destructans M2334 G. destructans M2335 G. destructans M2334 G. destructans M2335 | P083 | G. destructures M1379 G. destructures M1380 G. destructures M1383 G. destructures M1383 G. destructures M2327 G. destructures M2330 G. destructures M2333 G. destructures M2334 G. destructures M2335 | SRP72 | G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2330 G. destructans M2332 G. destructans M2332 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M235 G. destructans M235 G. destructans M235 G. destructans M235 G. destructa | VPS13 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M2334 G. destructans M2334 G. destructans M2335 |
| | 101 | G. destructans M1379 G. destructans M1389 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2325 G. destructans M2330 G. destructans M2331 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2333 G. destructans M2335 | P083 | G. destructures M1379 G. destructures M1380 G. destructures M1383 G. destructures M1383 G. destructures M2327 G. destructures M2330 G. destructures M2333 G. destructures M2334 G. destructures M2335 G. destructures M233 | SRP72 | G. destructures M1379 G. destructures M1380 G. destructures M1381 G. destructures M2325 G. destructures M2322 G. destructures M2332 G. destructures M2332 G. destructures M2333 G. destructures M2334 G. destructures M2335 G. destructures M2335 G. destructures M2335 G. destructures M2336 G. destructures M2337 | VPS13 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2332 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M2335 G. destructans M2334 G. destructans M2335 G. destructans M2335 G. destructans M2334 G. destructans M2334 G. destructans M2335 G. destructans M2335 G. destructans M2335 G. destructans M2334 G. destructans M2335 G. destructans M2335 |
| | PCS | G. destructans M1379 G. destructans M1389 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M2335 G. destructans M2336 G. destructans M2336 G. destructans M2337 G. destructans M2337 G. destructans M2338 | P083 | G. destructures M1379 G. destructures M1380 G. destructures M1383 G. destructures M1383 G. destructures M2325 G. destructures M2332 G. destructures M2333 G. destructures M2333 G. destructures M2333 G. destructures M2334 G. destructures M2335 G. destructures M2335 G. destructures M2335 G. destructures M2336 G. destructures M2337 G. destructures M2337 G. destructures M2338 G. destructures M2337 G. destructures M2338 | SRP72 | G. destructures M1379 G. destructures M1380 G. destructures M1380 G. destructures M2325 G. destructures M2327 G. destructures M2332 G. destructures M2333 G. destructures M2333 G. destructures M2334 G. destructures M2335 G. destructures M2337 G. destructures M2337 G. destructures M2338 | VPS13 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M2335 |
| | 101 | G. destructans M1379 G. destructans M1389 G. destructans M1381 G. destructans M1383 G. destructans M2325 G. destructans M2327 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M2335 G. destructans M2336 G. destructans M2337 G. destructans M2337 G. destructans M2338 G. destructans M2338 G. destructans M2338 G. destructans M2338 G. destructans M2337 G. destructans M2338 G. destructans M2338 G. destructans M2338 G. destructans M2338 G. destructans M2338 | P083 | G. destructures M1379 G. destructures M1380 G. destructures M1383 G. destructures M1383 G. destructures M2325 G. destructures M2332 G. destructures M2333 G. destructures M2333 G. destructures M2333 G. destructures M2334 G. destructures M2335 G. destructures M2335 G. destructures M2336 G. destructures M2337 G. destructures M2338 | SRP72 | G. destructures M1379 G. destructures M1380 G. destructures M1380 G. destructures M2325 G. destructures M2322 G. destructures M2332 G. destructures M2333 G. destructures M2333 G. destructures M2334 G. destructures M2335 G. destructures M2335 G. destructures M2335 G. destructures M2335 G. destructures M2337 G. destructures M2338 G. destructur | VP813 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2327 G. destructans M2327 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M2335 |
| | PCS | G. destructans M1379 G. destructans M1389 G. destructans M1381 G. destructans M1383 G. destructans M2327 G. destructans M2332 G. destructans M2333 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M2335 G. destructans M2336 G. destructans M2337 G. destructans M2338 G. destructans M2338 G. destructans M2339 | P083 | G. destructures M1379 G. destructures M1380 G. destructures M1383 G. destructures M2325 G. destructures M2327 G. destructures M2330 G. destructures M2333 G. destructures M2333 G. destructures M2334 G. destructures M2335 G. destructures M2338 G. destructures M2339 | SRP72 72 | G. destructures M1379 G. destructures M1380 G. destructures M1381 G. destructures M2325 G. destructures M2327 G. destructures M2330 G. destructures M2331 G. destructures M2333 G. destructures M2333 G. destructures M2335 G. destructures M2335 G. destructures M2335 G. destructures M2336 G. destructures M2337 G. destructures M2338 G. destructures M2339 G. destructures M2339 | VP813 | G. destructans M1379 G. destructans M1379 G. destructans M1380 G. destructans M1381 G. destructans M1383 G. destructans M2327 G. destructans M2331 G. destructans M2333 G. destructans M2333 G. destructans M2334 G. destructans M2335 G. destructans M2335 G. destructans M2336 G. destructans M2337 G. destructans M2338 G. destructans M2338 G. destructans M2337 G. destructans M2338 G. destructans M2338 G. destructans M2339 G. destructans M2337 G. destructans M2338 G. destructans M2338 G. destructans M2337 G. destructans M2337 G. destructans M2338 G. destructans M2339 |

Technical Appendix Figure 2. Maximum parsimony trees derived from individual target sequences. Alpha-L-rhamnosidase (*ALR*), 530 aligned nucleotides with 81 nt difference between *Geomyces destructans* and *G. pannorum*; 3'(2'),5'-bisphosphate nucleotidase (Bpntase), 667 nt/49

nucleotide difference; dynein (*DHC1*), 417 nt /27 difference; gephyrin molybdenum cofactor biosynthesis protein (*GPHN*), 522 nt/94 nt difference; peroxisomal-coenzyme A synthetase (*PCS*), 719 nt/101 nt difference; FACT complex subunit (*POB3*), 413 nt/32 nt difference; signal recognition particle protein 72 (*SRP72*), 613 nt/72 nt difference; vacuolar protein sorting-associated protein (*VPS13*), 527 nt/39 nt difference. The tree topologies were identical when neighbor-joining methods were used for analysis. Scale bars indicate number of nucleotide substitutions per site.

Technical Appendix Figure 3 (below). Multiple alignments of 8 target gene fragments. Synonymous substitutions are shaded light gray while nonsynonymous substitution are dark gray and amino acid changes are highlighted in red. A smaller fragment of nucleotides used in phylogenetics construct was used in this comparison. Putative amino acid sequences for *Geomyces destructans* and *G. pannorum* were deduced by using EMBOSS Transeq (EMBL-EBI, Cambridgeshire, UK). Homologous sequences from either *Ajellomyces dermatiditis*, *Arthroderma otae*, *Aspergillus nidulans*, *Aspergillus clavatus*, *Botryotinia fuckeliana*, *Glomerella graminicola*, *Nectria hematococca*), *Sclerotinia sclerotiorum*, and *Verticillium albo-atrum* were included in this comparison.

| Gd-DNA Gp-DNA An-DNA | | | | | CTC CTC | C TCT | ACA ACA | | A CTO | C TTO ATO | GCA GCT | CCG CCA | GAT GAT | GCG GCG | CCG CCA | | GTI GTC | ACC ACT | G GTO C GTO | |
|----------------------------|-----|-----|-----|-----|------------|-------|------------|-----|-------|--------------|------------|------------|------------|------------|--------------|-----|------------|------------|----------------|-----|
| Va-DNA | | | | | GAI | ACC | GTC | CAG | G CTC | CAI | GCG | GGT | GAC | GCC | GAG | CCI | GTI | CGI | A CGC | |
| Gd-PRO | | | | | | | | K | L | L | A | Ρ | D | A | Р | Ρ | V | Т | V | |
| Gp-PRO | | | | | | | | K | L | I | A | Ρ | D | A | Р | Ρ | V | Т | V | |
| An-PRO | | | | | | | | Q | L | V | A | Ρ | N | А | Ρ | Ρ | V | R | V | |
| Va-PRO | | | | | | | | Q | L | H | A | G | D | A | \mathbf{E} | Ρ | V | R | R | |
| Gd-DNA | ACA | GAA | GAG | GTC | AAC | CCA | GTC | GAT | ATT | ATC | AAG | ACA | AAG | TCC | GGG | AAA | ACA | GTC | ATT | GAT |
| Gp-DNA | ACA | GAA | GAG | CTG | AGC | CCA | ACT | GAG | ATT | ATC | AAG | ACA | AAG | TCC | GGC | AAA | ACG | GTC | ATT | GAC |
| An-DNA | ACC | GAA | GTG | GTC | AAT | CCA | GTT | GAA | ATC | ATT | CGC | ACG | CCG | TCC | GGC | AAA | GTA | ATC | ATT | GAT |
| Va-DNA | CTC | GAA | ATC | GTC | AAG | CCC | ATC | GAA | AAG | ATC | ACG | ACC | CCC | TCC | GGA | AAG | ACG | GTG | CTT | GAC |
| Gd-PRO | Т | Ε | Ε | V | Ν | Ρ | V | D | I | I | K | Т | Κ | S | G | Κ | Т | V | I | D |
| Gp-PRO | Т | Ε | Ε | L | S | Ρ | т | Ε | I | I | K | Т | K | S | G | K | Т | V | I | D |

ALR (Alpha-L-rhamnosidase): \Box 450 bases aligned (Gd = Geomyces destructans, Gp = Geomyces pannorum An = Aspergillus nidulans, Va = Verticillium albo-atrum)

| An-PRO | | Г | Ε | V | V | N | Ρ | V | Ε | I | I | R | Г | r - | P | S | G | Κ | V | | | Ι | D |
|--------|----|-------------------------|----------|-------|------|------|-------|-------|-------|-------|-------|------|------|-------|------|-------|------|------|------|------|------------------|------|----|
| Va-PRO | | . 1 | Ε | I | V | K | Ρ | Ι | Ε | K | I | Т | I | [| P | S | G | K | Т | 7 | 7 | | D |
| Gd-DNA | T | IT G | GG C | CAG A | AC C | TG G | TA G | GGC A | AAG (| CTT | CGT | GT | C AG | GC T | CC G | TC (| CGA | CTC | cc | C GC | CG G | GT C | A |
| Gp-DNA | T | FT G | GG C | CAG A | AC C | TC G | TA G | GGG A | AA (| CTT | CGT | GT | C AF | AC TO | CC G | TC (| CGA | CTC | CC | T GC | CC G | GT G | A |
| An-DNA | T. | TT G | GG C | CAA A | AC C | TC G | TT G | GC (| CGT (| STC | CGG | AT | C C | GC T | CC G | TA | AAG | AAG | ; AC | C GI | G G | GC C | A |
| Va-DNA | T. | TT G | GG C | AG A | AC C | TC G | TA G | GC 1 | AC C | CTT | CGG | GT | C AF | AC A | AA G | TC | AGG | GGT | CC | с с | GC G | GC C | A |
| Gd-PRO | Ι | F (| G | Q | N | L | V | G | K | L | R | V | S | 3 3 | s | V | R | L | P | Z | A (| G | Q |
| Gp-PRO | Ι | F (| G | Q | N | L | V | G | K | L | R | V | Ν | 1 | S | V | R | L | Ρ | I | A (| 3 | E |
| An-PRO | Ι | F (| G | Q | N | L | V | G | R | V | R | I | F | 2 | S | V | K | K | Т | 7 | 7 (| G | Н |
| Va-PRO | Ι | <u> </u> | G | Q | Ν | L | V | G | Y | L | R | V | Ν | 1 | K | V | R | G | Ρ | F | <mark>२</mark> (| 6 | Η |
| Gd-DNA | G | AAG | ATC | TCA | TTT | ACA | . CAI | GT | C GAA | A GI | G C | TC (| GAG | AAT | GGC | GA | A A: | rc g | GC | ACA | CGT | CCG | СТ |
| Gp-DNA | G | AAA | ATC | ACA | TTT | ACA | CAC | GT(| GAC | G GT | A C | TC (| GAG | AAT | GGC | GA | A A | ΓT A | GC | ACC | CGA | CCG | СТ |
| An-DNA | С | TCT | ATC | : ATT | CTC | AAG | CAI | GCC | GAA | A GI | G C | TC (| GAG | AAT | AGC | GA | A C | гт G | GA | ACG | CGT | CCG | СТ |
| Va-DNA | т | AAA | ATC | : ACC | CTG | CTG | CAC | GCC | GAC | G GT | Т С | TC (| GAG | AAG | GGC | GA | G C | ΓT G | GC | ATC | CGG | CCG | СТ |
| Gd-PRO | | Κ | I | S | F | Т | Н | V | Е | V | · . | L | Е | N | G | Е | | Γ | G | T | R | Ρ | L |
| Gp-PRO | | Κ | I | Т | F | Т | Η | V | Е | V | · . | L | Ε | Ν | G | Ε | 1 | Γ | S | Т | R | Ρ | L |
| An-PRO | | S | I | I | L | K | Η | A | Ε | V | · . | L | Ε | Ν | S | Ε |] | | G | Т | R | Ρ | L |
| Va-PRO | | K | I | Т | L | L | Η | A | Ε | V | | L | Ε | K | G | Ε |] | L | G | I | R | Ρ | L |
| Gd-DNA | Т | CGA | GGA | GCA | GTC | TGC | GTI | GAT | AC1 | T AT | T G | TC | TTT | TCT | GAA | AA | G GA | AG C | CTC | CGC | GGC | -= | |
| Gp-DNA | Т | CGA | GAA | GCA | GTA | CCC | GTC | GAT | AC | GI GI | 'C A' | TC : | TTT | TCT | GAT | AA | C GA | AG C | TC | CTG | AAC | | |
| An-DNA | G | CGA | GTG | GCC | AAG | GCC | CAC | GAC | C GAC | G AT | 'C A | TC | TCA | GCA | GGA | CA | G GA | AG A | TT | TGT | GAC | | |
| Va-DNA | G | CGT | GAC | : TGC | AAG | GCC | CGG | GAC | C ATO | C TA | СА | CC (| CTC | TGT | GGT | ' GA' | T GA | AG G | БСТ | GGC | GAA | TC | |
| Gd-PRO | | R | G | А | V | C | V | D | Т | I | | V | F | S | E | K | I | Ξ | L | R | G | - | |
| Gp-PRO | | R | E | А | V | P | V | D | Т | | | Ι | F | S | D | N | Η | £ | L | L | N | - | |
| An-PRO | | R | V | A | K | A | Q | D | E | I | | Ι | S | A | G | Q | I | 2 | I | C | D | - | |
| Va-PRO | | R | D | C | K | A | R | D | Ι | Y | | Т | L | C | G | D | Ι | Ξ | A | G | E | S | |
| Gd-DNA | _ | TGG | TCG | G CCG | AAA | TTC | ACA | A TTO | CAC | C GG | C T | TC (| CAG | TAC | GTG | CA | G GI | ГТ G | GAA | GGG | TGG | CCA | GC |
| Gp-DNA | - | TGG | TCC | CCA | AAA | TTC | ACA | A TTI | CA | GG GG | T T | TC (| CAG | TAC | GTG | CA | A G | ΓT G | SAT | GGG | TGG | CCA | GC |
| An-DNA | - | TGG | GCI | CCT | AGC | TTT | ACI | TTC | CA1 | GG GG | С Т | TC (| CGG | TAT | GTI | CA | G G | ΓT G | GAT | GGA | TGG | AGC | |
| Va-DNA | G | TAC | GAG | G CCT | CGC | TTC | ACC | TTC | C CA | G GG | С Т | TT (| CGC | TAT | GCC | CA | G G | rc g | AC | GAC | TGG | CCA | |
| Gd-PRO | | W | S | Ρ | K | F | Т | F | Η | G | ; | F | Q | Y | V | Q | 7 | 7 | E | G | W | Ρ | A |
| Gp-PRO | | W | S | Ρ | Κ | F | Т | F | Η | G | ; | F | Q | Y | V | Q | 7 | 7 | D | G | W | Ρ | A |
| An-PRO | | W | A | Ρ | S | F | Т | F | Η | G | ; | F | R | Y | V | Q | 7 | J | D | G | W | S | - |
| Va-PRO | | $\overline{\mathbf{v}}$ | T | P | R | ਸ | Т | ਸ | Н | G | | F | R | Y | A | 0 | 7 | J | D | | W | P | _ |

| Gd-DNA | A | ACT | GCG | GAT | GCT | GAA | CTC | CCT | | TAT | AAG | TCT | GAC | TTT | ACT | GCG | CTA | GTC | ATG | CAT | 445 |
|--------|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Gp-DNA | А | ACT | GCG | GAT | GCT | GAA | CTC | CCA | | TCT | TTG | TCT | GAC | TTC | ACT | GCA | CTA | GTC | ATG | CAT | 452 |
| An-DNA | - | ССТ | GAA | GAC | GCC | GAC | ACC | CCT | CTT | ACT | СTА | CAA | AGC | CTG | ACC | GCC | GAA | GTC | ATG | CAT | 444 |
| Va-DNA | - | TCC | GCA | GAT | ATT | GAC | | | | ATC | CTG | GAC | TCA | CTC | GAG | GCT | GTG | GTC | TGC | AAT | 459 |
| Gd-PRO | | Т | A | D | A | Ε | L | Ρ | - | Y | K | S | D | F | Т | А | L | V | М | Н | |
| Gp-PRO | | Т | A | D | A | Ε | L | Ρ | - | S | L | S | D | F | Т | А | L | V | М | Н | |
| An-PRO | | P | E | D | А | D | Т | Р | L | Т | L | Q | S | L | Т | А | E | V | М | Н | |
| Va-PRO | | S | A | D | I | D | - | - | - | I | L | D | S | L | E | А | V | V | C | Ν | |

BPntase (3'(2'), 5'-bisphosphate nucleotidase): ≈ 750 bases aligned; Alignment shows 3' region of the protein and the 3' UTR (Ss = Sclerotinia sclerotiorum; Af = Aspergillus fumigatus)

| Gd-DNA | | | | | | | | | | | AG | AGC | CAG | CCG | ATC | CGC | ATG | AGC | GAG | AAG | А |
|--------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
| Gp-DNA | | | | | | | | | | | AG | AGC | CAG | CCA | ATC | CGC | ATG | AGC | GAG | AAG | А |
| Ss-DNA | | | | | | | | | | | AG | GGT | CAA | тст | ATT | CAA | ATG | AAG | CCA | GTT | А |
| Af-DNA | | | | | | | | | | | AG | AGC | AAG | CCC | ATC | TCG | ATG | CGT | CCC | GTT | С |
| Gd-PRO | | | | | | | | | | | | S | Q | P | I | R | М | S | E | K | |
| Gp-PRO | | | | | | | | | | | | S | Q | Ρ | I | R | М | S | Ε | Κ | |
| Ss-PRO | | | | | | | | | | | | G | Q | S | I | Q | М | K | Ρ | V | |
| Af-PRO | | | | | | | | | | | | S | K | Ρ | I | S | М | R | P | V | |
| Gd-DNA | AG | GAC | ATC | ACC | GAT | GCC | ACT | TTC | TGC | GAG | AGT | GTT | GAG | GCT | GGC | CAC | TCA | TCT | CAC | GAC | G |
| Gp-DNA | AG | GAT | ATC | ACC | GAT | GCC | ACT | TTC | TGC | GAG | AGT | GTT | GAG | GCT | GGC | CAC | TCG | TCG | CAT | GAC | G |
| Ss-DNA | CG | GAT | ΤΤΑ | AGT | CAA | GCT | ACA | TTC | TGT | GAG | AGT | GTT | GAG | GCA | GGT | CAC | TCT | TCC | CAT | GGC | G |
| Af-DNA | CG | GAT | ATA | AAA | CAG | GCT | GTC | TTC | TGT | GAA | GGA | GTT | GAG | GCT | GCC | CAC | TCT | GCT | CAA | GGC | G |
| Gd-PRO | K | D | I | Т | D | A | | F | С | E | S | V | Ε | А | G | Н | S | S | Н | D | |
| Gp-PRO | Κ | D | I | Т | D | А | Т | F | С | Ε | S | V | Ε | А | G | Η | S | S | Η | D | |
| Ss-PRO | Т | D | L | S | Q | А | Т | F | С | Ε | S | V | Ε | А | G | Η | S | S | Η | G | |
| Af-PRO | P | D | I | K | Q | A | V | F | С | Ε | G | V | Ε | A | A | Η | S | A | Q | G | |
| Gd-DNA | AC | CAA | TCT | CAG | ATC | GCC | CAG | AAG | CTG | CAG | ATC | AGC | AAG | CCG | AGC | GTG | CGG | ATG | GAT | TCG | С |
| Gp-DNA | AC | CAG | TCT | CAG | ATC | GCA | CAG | AAG | CTG | CAG | ATT | AGC | AAG | CCA | AGC | GTG | CGA | ATG | GAT | TCG | С |
| Ss-DNA | AT | CAA | CAT | GCC | ATT | GCT | ACC | AAA | TTG | GGT | GTT | ACC | AAG | GCT | AGT | GTC | CGA | ATG | GAT | TCA | С |
| Af-DNA | AC | AAC | GCT | GCC | GTC | GCT | CAG | CTC | CTG | GGT | ATC | ACC | TCC | CCC | AGC | GTG | CGA | CTC | GAC | TCG | С |
| Gd-PRO | D | Q | S | Q | I | A | Q | K | L | Q | I | S | K | P | S | V | R | М | D | S | |
| Gp-PRO | D | Q | S | Q | I | A | Q | Κ | L | Q | I | S | K | Ρ | S | V | R | М | D | S | |

| Ss-PRO | D | Q | H | A | I | А | т | K | L | G | V | Т | Κ | A | S | V | R | М | D | S | |
|--------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---|
| Af-PRO | D | N | A | A | V | А | Q | L | L | G | I | Т | S | Ρ | S | V | R | L | D | S | |
| | | | | | | | | _ | | | | | | | | | | | | | |
| Gd-DNA | AG | GCC | AAG | TAT | GCC | TCG | ATC | GCC | CGT | GGC | GCT | GGG | GAT | ATT | TAC | CTG | AGA | CTT | CCA | ACC | A |
| Gp-DNA | AG | GCA | AAG | TAT | GCC | TCG | ATC | GCT | CGT | GGT | GCG | GGG | GAT | ATT | TAC | CTC | AGA | CTT | CCA | ACC | А |
| Ss-DNA | AA | GCT | AAA | TAT | GGA | TCG | ATC | GCG | AGA | GGT | GCT | GGA | GAC | ATT | TAC | CTT | AGA | CTT | CCC | GTT | А |
| Af-DNA | AG | GCC | AAG | TAC | TGC | TCA | ATT | GCT | AGA | GGC | GCA | GGC | GAT | ATC | TAC | СТА | CGG | СТА | ССТ | GTC | А |
| Gd-PRO | Q | A | K | Y | A | S | I | А | R | G | А | G | D | Ι | Y | L | R | L | Ρ | Т | |
| Gp-PRO | Q | A | K | Y | A | S | I | А | R | G | А | G | D | Ι | Y | L | R | L | Ρ | Т | |
| Ss-PRO | Q | A | Κ | Y | G | S | I | A | R | G | А | G | D | I | Y | L | R | L | Ρ | V | |
| Af-PRO | Q | A | K | Y | C | S | I | A | R | G | A | G | D | I | Y | L | R | L | Ρ | V | |
| Gd-DNA | GC | GCA | ACG | TAC | CAA | GAG | AAG | ATC | TGG | GAT | CAC | GCT | GCT | GGA | GAC | CTG | ATT | GTT | CGA | GAG | G |
| Gp-DNA | GC | GCA | ACG | TAC | CAG | GAG | AAG | ATC | TGG | GAT | CAC | GCT | GCT | GGA | GAC | CTG | ATT | GTT | AGG | GAG | G |
| Ss-DNA | GC | GCG | ACT | TAC | CAA | GAG | AAG | ATT | TGG | GAT | CAT | GCT | GCT | GGA | GAT | CTT | ATT | GTA | AGA | GAG | G |
| Af-DNA | GΑ | AAG | GAC | TAC | CAG | GAG | AAG | ATC | TGG | GAT | CAT | GCG | GCT | GGC | GAT | CTC | ATT | GTC | CGC | GAG | G |
| Gd-PRO | S | A | Т | Y | Q | Е | K | I | W | D | Н | A | А | G | D | L | I | V | R | Ε | |
| Gp-PRO | S | A | Т | Y | Q | Ε | K | I | W | D | Н | A | А | G | D | L | I | V | R | Ε | |
| Ss-PRO | S | A | Т | Y | Q | Е | K | I | W | D | Η | А | А | G | D | L | I | V | R | Ε | |
| Af-PRO | R | K | D | Y | Q | Ε | K | I | W | D | Н | A | A | G | D | L | I | V | R | Ε | |
| Gd-DNA | CG | GGA | GGA | CAG | GTT | ACG | GAT | TCA | CTA | GGC | AGA | CGT | CTG | GAT | TTC | AGC | AAG | GGT | AGA | ACT | Т |
| Gp-DNA | CA | GGA | GGA | CAG | GTT | ACG | GAT | TCA | CTG | GGC | AGA | CGT | CTG | GAT | TTC | AGC | AAG | GGT | AGA | ACC | Т |
| Ss-DNA | CA | GGT | GGA | CAG | GTT | ACT | GAT | TCT | CTC | GGA | CGA | AGA | TTG | GAT | TTC | AGC | AAG | GGA | AGA | ACT | Т |
| Af-DNA | СТ | GGT | GGA | CAA | GTG | ACC | GAT | ATC | TAT | GGC | CAG | CGC | TTG | GAT | TTC | AGC | AAG | GGA | CGC | ACT | Т |
| Gd-PRO | A | G | G | Q | V | т | D | S | L | G | R | R | L | D | F | S | K | G | R | Т | |
| Gp-PRO | А | G | G | Q | V | Т | D | S | L | G | R | R | L | D | F | S | K | G | R | Т | |
| Ss-PRO | А | G | G | Q | V | Т | D | S | L | G | R | R | L | D | F | S | Κ | G | R | Т | |
| Af-PRO | Α | G | G | Q | V | Т | D | Ι | Y | G | Q | R | L | D | F | S | K | G | R | Т | |
| Gd-DNA | ΤG | GCT | GAG | AAT | AAG | GGT | GTC | GTT | GCC | GCA | CCA | CAG | GCT | CTA | CAC | GCA | CGA | GTC | CTT | GAG | G |
| Gp-DNA | ΤG | GCT | GAG | AAT | AAG | GGT | GTC | GTT | GCC | GCA | CCA | CAG | GCT | СТА | CAT | GCA | CGA | GTC | CTT | GAG | G |
| Ss-DNA | ΤG | GCT | GAA | AAC | AAG | GGT | GTC | GTT | GCA | GCT | CCC | GCA | GCC | ATT | CAC | GAC | CAC | GTT | TTG | GAG | G |
| Af-DNA | ΤG | GCT | GCC | AAC | AAG | GGA | GTC | GTC | GCC | GCT | CCA | GAG | GCC | ATC | CAG | GAC | CAG | GTT | ATT | AGT | G |
| Gd-PRO | L | A | E | Ν | K | G | V | V | A | A | P | Q | A | L | Н | A | R | V | L | E | - |
| Gp-PRO | L | А | Ε | Ν | K | G | V | V | А | А | Ρ | õ | А | L | Н | А | R | V | L | Ε | |
| Ss-PRO | L | A | Ε | Ν | K | G | V | V | A | A | Р | A | A | I | Н | D | Н | V | L | Е | |
| Af-PRO | L | A | A | Ν | K | G | V | V | A | A | Ρ | E | A | I | Q | D | Q | V | I | S | |

| Gd-DNA | ΤT | GTC | AAG | GAG | GTC | CTT | GGC | AAG | AAG | GGA | AAC | CTA | TAG | CAGATATGA |
|--------|-----|-------|-------|-------|-------|-------|-------|---------------|-------|-------|-------|-------|------|--------------------|
| Gp-DNA | ΤT | GTC | AAA | GAA | GTC | CTG | GGC | AAG | AAA | GGA | AAC | CTA | TAG | TAGATATGA |
| Ss-DNA | ΤG | GTT | AAG | GAG | GTT | TTG | GGG | CCC | AAG | AAA | TAA | A | TTG | TTCATATATTCGTCACAA |
| Af-DNA | CC | GTC | AAG | ACG | GTC | CTG | AAG | CTA | TGA | AGGA | ATGA | CGCGA | ACG | GACCAACTGTTGTATCGA |
| Gd-PRO | V | V | Κ | E | V | L | G | K | K | G | Ν | L | * | |
| Gp-PRO | V | V | Κ | Ε | V | L | G | Κ | Κ | G | Ν | L | * | |
| Ss-PRO | V | V | Κ | Ε | V | L | G | Ρ | Κ | K | * | | | |
| Af-PRO | A | V | Κ | Т | V | L | Κ | L | * | | | | | |
| | _ | | | _ | | | | | | | | | | |
| Gd-DNA | ACA | AATTO | GAAA' | TAGA | TTCT | 4(| CATA | rcgt <i>i</i> | ATAA | CT-AC | FCCG | CTTGG | G-GA | CCCTCCAATT |
| Gp-DNA | ACA | AGCT | G! | TAGA | TTCT# | 4(| CATAC | rcgt <i>i</i> | ATAA | CT-AC | FCCG | CTTGA | -GA | CTCCACAATT |
| Ss-DNA | AT2 | AAAA | GCCA | IGAT/ | ACCTT | GAT | CCAC | rtgt <i>i</i> | ACATO | CG-AG | CACC | ATAGA | TAT | АТСТАСААТА |
| Af-DNA | AT(| CACTA | AAAC | CCGT | ГСТАА | AA(| CCTT | rgtt <i>i</i> | AGATO | CCTG | CACG | CTTGA | TGC | GCCTAAAAGT |
| | | | | | | | | | | | | | | |
| Gd-DNA | CTZ | ATGA | CA· | | -ATA | raag- | A(| GCAA | CATA | ATAC- | -ATG | GACG- | -AA | TCGTCTATTT |
| Gp-DNA | CTZ | ATGA | CA· | | -ATA | raag- | AA | ACAA | CATA | ATAC- | -ATG | GACG- | -AA | TCGTCTATTT |
| Ss-DNA | CC | FACA | AATG | | -ACA | TAT- | C | ГСТАС | GAGAT | TAT- | -TTG | GATAT | TCA | TCCACTACTT |
| Af-DNA | ACA | ATGA | GATA | GATA | CCAA | TGG | GAAAA | ACAG | GAGAC | CTCTC | GCTG | GAAT- | -AT | ACATGTACAG |
| | | | | | | | | | | | | | | |
| Gd-DNA | GA | TCTT(| CTTG | GCCT | ГСАА | CCTGA | ATCG | FCTCA | ACCGI | TGA | CGAA | AATTC | CCT | TCCCCTTG |
| Gp-DNA | GA | ICTT(| CTTC | GCCT | FCAG | CTTGA | ATCG | ГСТСС | GCCAT | TGA | CGAA | GATTC | CCT | TCCCCTTA |
| Ss-DNA | AA | TCTT(| CTTA | TTCT | ГСАА | CTTA | ATCT | CCTC | ICCAI | TGA | CAAA | GATTC | CCT | TCCCCTTA |
| Af-DNA | AA | ACAG | CCCC | AGAC | CCTG | TCCA | AAGAA | AAATO | GCCAP | AAGTA | AAA' | TAGAA | ACC | ACCCCAGATC |
| | | | | | | | | | | | | | | |
| Gd-DNA | TAT | rggc | rcag(| GCTT | CCTCC | CACTO | GGCG | GATT | rccgo | CAGCA | AAAC | IGCAG | SAAC | CACTTCC |
| Gp-DNA | TAT | rggc | rcag(| GCTT(| CCTC | CATTO | CACGA | AATT | CCG | CAGCO | GAAC' | IGGAG | GAAC | AACCTCC |
| Ss-DNA | TAC | CGGT | FCTG | GAAC | CTCC | CACT | TCT# | AATT | rgcgo | CAGCO | GAAA | AGTAA | TAC | AACTTCC |
| Af-DNA | ACO | CGAA | ICTT. | -CTT(| GGCC | TCA | GTCT | GATTO | GTCT | CTCC | GTTC | ACAAA | AAT | ACCCTTGCCC |
| | | | | | | | | | | | | | | |
| Gd-DNA | TT(| CTCC | GGGC | CCT-(| CCAG | CAATA | ATTC | FCGT: | IGGCI | rgcg | GTGT | GCTGG | CCG | TCATGCCCTT |
| Gp-DNA | TT(| CTCT | GGGC | CCT-(| CCAG | CAATA | ATTC | FCGT | rggci | rgcgo | GTGT | GCTAG | CCG | TCATGCCCTT |
| Ss-DNA | TT(| CTCT | GGTC | CTT-(| CTAA | CAATA | ATAC | GTGTA | AGGTI | IGTG | GTGT | GCTCG | CTT | TCACAAATCT |
| Af-DNA | TT(| GTAA | GGCT | CTGG | CTTC | CGCCA | ATTC | C-TC | GATTI | CCG | CCGC | GAATT | GTG | TCACAACGTT |
| | | | | | | | | | | | | | | |
| Gd-DNA | CG | GCAC | rggcz | AACT | CGA- | TAGGA | ATGT | GAGTA | AG 74 | 14 | | | | |
| Gp-DNA | CG | GCAC | rggc2 | AACT | CGA-1 | TGGA | ATGT | GAGTA | AC 74 | 11 | | | | |

Ss-DNA TGGAACGGGTAATTCGA-TAGGATGAGAGTAC 759 Af-DNA TTTGTCGACTCCCTCAAGCAGAATACGAGTAG 775

DHC1 (Cytoplasmic dynein heavy chain): 418 bases aligned (Ss = Sclerotinia sclerotiorum, Bf = Botryotinia fuckeliana)

| Ss-DNA | GAT | GCT | GAA | TAC | CTA | GAT | CCA | ATC | CTT | AAC | CAC | GTT | CTT | AAC | AAA | GAG | TAT | CAA | AAG | ACT | 60 |
|--------|---------------|--------------|--------|--------|----------|--------|--------------|--------|----------|----------|----------|----------|----------|--------|--------------|----------|-----|--------------|--------|----------|-----|
| Bf-DNA | GAT | GCC | GAA | TAC | CTG | GAC | CCA | ATT | CTT | AAC | CAC | GTT | CTC | AAC | AAA | GAG | TAC | CAA | AAG | ACT | 60 |
| Gd-DNA | GAT | GCC | GAG | CAT | TTG | GAT | CCA | ATC | CTT | AAC | CAC | GTC | CTC | AAC | AAG | GAA | TAC | CAA | AAG | ACT | 60 |
| Gp-DNA | GAT | GCC | GAG | CAT | TTG | GAT | CCG | ATC | CTT | AAT | CAT | GTC | CTC | AAC | AAG | GAG | TAC | CAA | AAG | ACT | 60 |
| Ss-PRO | D | А | Ε | Y | L | D | Р | I | L | Ν | Н | V | L | Ν | K | Е | Y | 0 | K | Т | |
| Bf-PRO | D | А | Е | Y | L | D | Р | I | L | Ν | Н | V | L | Ν | K | Е | Y | õ | K | Т | |
| Gd-PRO | D | А | Ε | Н | L | D | Ρ | I | L | Ν | Н | V | L | Ν | K | Е | Y | õ | K | Т | |
| Gp-PRO | D | A | Ε | Η | L | D | Ρ | I | L | Ν | Η | V | L | Ν | K | Ε | Y | Q | K | Т | |
| Ss-DNA | GGT | GGA | CGT | GTT | СТТ | ፚጥጥ | CAG | ሮሞሞ | GGT | AAG | CAA | GAA | ፚጥጥ | GAC | ጥጥጥ | ТCG | CCC | GCA | ጥጥጥ | AAG | 120 |
| Bf-DNA | GGT | GGG | CGT | GTT | CTC | ATC | CAG | СТТ | GGA | AAG | CAA | GAA | ATC | GAT | TTC | TCG | CCC | GCA | TTC | AAG | 120 |
| Gd-DNA | GGT | GGA | CGT | GTC | CTC | ATC | CAG | СТС | GGT | AAA | CAA | GAG | ATC | GAT | TTC | TCC | CCA | GCC | TTC | AAG | 120 |
| Gn-DNA | GGC | GGG | CGT | GTT | CTC | ATC | CAG | СТТ | GGC | AAA | CAA | GAA | ATC | GAT | TTC | TCC | CCA | GCC | TTC | AAG | 120 |
| Ss-PRO | G | G | R | V | T, | Т | 0 | T. | G | K | 0 | E | Т | D | F | S | P | A | F | K | 100 |
| Bf-PRO | G | G | R | v | L | Ī | Õ | L | G | K | Õ | Ē | Ī | D | F | S | P | A | F | K | |
| Gd-PRO | G | G | R | V | L | I | Õ | L | G | K | Õ | E | I | D | F | S | P | A | F | K | |
| Gp-PRO | G | G | R | V | L | I | Q | L | G | K | Q | Ε | I | D | F | S | Ρ | A | F | K | |
| | 3 00 0 | m a c | | ШQQ | | | C A H | 007 | mom | C C 7 | | mma | C C 7 | 000 | C A H | 7 | ПСC | л с п | 000 | | 100 |
| SS-DNA | ATC | TAC | CTT | TCC | ACT | AGA | GAT | CCA | TCT | GCA | ACA | TTTC | GCA | CCG | GAT | ATT | TGC | AGT | CGG | ACA | 100 |
| BI-DNA | ATT | TAC | CTT | TCC | ACC | AGA | GAT | CCA | TCT | GCA | ACA | mmm | GCA | CCG | GAC | ATT | TGC | AGT | CGC | ACA | 100 |
| Gu-DNA | AIC | | CIC | TCG | ACC | AGA | GAI | CCA | | CCT | ACG | | GCA | CCA | GAC | | TGC | AGI | CGC | ACA | 100 |
| | AIC | V | T | CA | ACC m | AGA | GAI | D | ICI C | GCT 7 | ACA m | T T T | GCA 7 | D | GAI | GIA | C | AGI | DUJU | ACA m | 100 |
| Df_DDO | <u>⊥</u> т | ı v | Т | c c | т Т | D D | D D | г D | с С | A N | т Т | L. L. | A N | г D | | т | C | c c | D | т т | |
| DI-PRO | <u>⊥</u> т | I V | т | с С | т т | л D | D | r D | с С | A N | T T | r T | A N | r D | D | ⊥ т | C | с С | л D | т т | |
| Gu-PRO | 1 - | I | Ц т | с С | I m | л D | D | r D | с С | A | I m | r T | A | r D | D | | C | с С | л Л | 1 | |
| GD-БКО | Ţ | Ţ | Ц | 2 | .Т. | ĸ | ע | F | 2 | А | .Т. | Ľ | А | Ľ | U | V | C | 5 | K | .Т. | |
| Ss-DNA | ACG | TTT | GTC | AAT | TTC | ACT | GTC | ACA | CAA | AGC | AGT | ТТА | CAA | ACA | CAG | TCA | СТТ | AAT | GAC | GTC | 240 |
| Bf-DNA | ACA | TTT | GTT | AAT | TTC | ACA | GTC | ACA | CAG | AGT | AGT | TTG | CAA | ACA | CAG | TCA | CTC | AAT | GAC | GTT | 240 |

| Gd-DNA | АСТ | TTC | GTC | ААТ | TTC | ACC | GTC | ACC | CAG | AGC | AGT | CTC | CAA | ACG | CAA | ТСА | ͲͲG | AAC | GAA | GTC | 240 |
|--------|-----|--------|-----|-----|--------|--------|-----|----------|--------|-----|-----|-----|--------|--------|--------|-----|-----|-----|-----|------|-----|
| GD-DNA | ACC | TTC | GTG | AAT | TTC | ACT | GTC | ACC | CAG | AGC | AGT | СТС | CAA | ACA | CAA | TCA | TTG | AAC | GAA | GTC | 240 |
| Ss-PRO | T | F | V | N | F | Ψ | V | лос Т | 0 | S | S | T, | 0 | т Т | 0 | S | T. | N | D | V | 210 |
| Bf-PRO | Ť | - म | v | N | - म | т Т | V | Ť | Õ | S | S | T. | Õ | Ť | Õ | S | Т. | N | D | v | |
| Cd-PRO | Ψ | - ਸ | 77 | N | - ਸ | Ψ | 77 | Ψ | \sim | S | S | т. | \sim | Ψ | \sim | S | т. | N | E | v | |
| Gn-PRO | Ψ | - ਸ | 77 | N | - ਸ | т т | 77 | Ψ | \sim | S | S | Т. | \ ○ | т Т | \sim | S | т. | N | E | v | |
| 00 110 | T | T | v | IN | T | T | v | T | × | 0 | 0 | ш | × | T | × | 0 | ш | IN | ш | v | |
| Ss-DNA | CTC | AAA | TCT | GAG | CGA | CCT | GAT | GTG | GAT | GAG | AGG | CGC | TCA | AAT | CTC | ATC | AAA | TTA | CAG | GGT | 300 |
| Bf-DNA | CTC | AAA | TCC | GAA | CGA | CCT | GAT | GTG | GAC | GAG | AGA | CGC | тст | AAT | CTC | ATC | AAG | TTA | CAA | GGC | 300 |
| Gd-DNA | CTG | AAA | TCT | GAG | CGA | CCT | GAC | GTG | GAT | GAG | CGA | AGA | TCC | AAC | CTG | ATC | AAA | TTA | CAG | GGA | 300 |
| Gp-DNA | CTG | AAA | TCT | GAG | CGA | CCT | GAC | GTG | GAT | GAA | CGA | AGA | TCC | AAC | CTG | ATC | AAA | TTG | CAG | GGA | 300 |
| Ss-PRO | L | K | S | Е | R | Ρ | D | V | D | E | R | R | S | Ν | L | I | K | L | Q | G | |
| Bf-PRO | L | K | S | Е | R | Ρ | D | V | D | Ε | R | R | S | Ν | L | I | K | L | Q | G | |
| Gd-PRO | L | K | S | Ε | R | Ρ | D | V | D | Ε | R | R | S | Ν | L | I | K | L | Q | G | |
| Gp-PRO | L | K | S | Ε | R | Ρ | D | V | D | Е | R | R | S | Ν | L | I | K | L | Q | G | |
| | | | | | | | | | | | | | | | | | | | | | |
| Ss-DNA | GAA | TTC | AAA | GTT | CAT | CTT | AGA | CAG | CTC | GAG | AAA | CGC | TTG | TTG | CAA | GCA | TTG | AAC | GAA | TCA | 360 |
| Bf-DNA | GAA | TTC | AAA | GTT | CAC | CTC | AGG | CAG | CTC | GAG | AAG | CGC | TTG | CTG | CAA | GCC | CTG | AAC | GAA | TCA | 360 |
| Gd-DNA | GAA | TTC | AAG | GTC | CAT | CTT | CGC | CAA | TTG | GAG | AAG | CGT | CTT | TTG | CAA | GCT | TTG | AAC | GAG | TCC | 360 |
| Gp-DNA | GAA | TTC | AAG | GTC | CAC | CTT | CGC | CAA | TTG | GAG | AAG | CGT | CTT | TTG | CAG | GCT | TTG | AAC | GAG | TCC | 360 |
| Ss-PRO | Ε | F | K | V | Н | L | R | Q | L | Ε | Κ | R | L | L | Q | А | L | Ν | Ε | S | |
| Bf-PRO | Ε | F | K | V | Н | L | R | Q | L | Ε | K | R | L | L | Q | А | L | Ν | Ε | S | |
| Gd-PRO | Ε | F | K | V | Н | L | R | Q | L | Ε | K | R | L | L | Q | А | L | Ν | Ε | S | |
| Gp-PRO | Ε | F | K | V | Н | L | R | Q | L | Е | K | R | L | L | Q | А | L | Ν | Ε | S | |
| | | | | | | | | | | | | | | | | | | | | | |
| Ss-DNA | CGT | GGC | AAT | ATT | CTC | GAT | GAT | GAT | AAC | GTC | ATT | GAA | ACT | CTC | GAA | ACT | TTG | AAG | AAG | G 43 | 18 |
| Bf-DNA | CGT | GGC | AAT | ATT | CTT | GAT | GAT | GAC | AAC | GTC | ATT | GAA | ACT | CTT | GAG | ACT | TTG | AAG | AAG | G 41 | 18 |
| Gd-DNA | CGT | GGC | AAT | ATC | TTG | GAT | GAT | GAC | AAC | GTC | ATT | GAG | ACT | CTC | GAG | ACG | TTG | AAG | AAG | G 41 | 18 |
| Gp-DNA | CGT | GGT | AAT | ATC | TTG | GAT | GAT | GAC | AAC | GTT | ATT | GAA | ACT | CTC | GAA | ACG | TTG | AAG | AAG | G 41 | 18 |
| Ss-PRO | R | G | Ν | I | L | D | D | D | Ν | V | I | Е | Т | L | E | Т | L | K | K | | |
| Bf-PRO | R | G | Ν | I | L | D | D | D | Ν | V | I | Е | Т | L | Ε | Т | L | K | K | | |
| Gd-PRO | R | G | Ν | I | L | D | D | D | Ν | V | I | Е | Т | L | Ε | Т | L | K | K | | |
| Gp-PRO | R | G | Ν | I | L | D | D | D | Ν | V | I | Ε | Т | L | Ε | Т | L | K | K | | |

GPHN (Gephyrin): ~300 bases aligned; the alignment starts with non-coding miscellaneous feature

| Gd-DNA Gp-DNA Nh-DNA Ac-DNA Gd-PRO Gp-PRO Nh-PRO Ac-PRO | AT AC AT AT | 2T 2T 2C 2TGCC | -TC- -TT- -TCA CTTG | CATT CATT TATT AATC | CTAA CTAA CTAA CAGA | CACG TTCG TTCG GCCA | TAA- CAG- AAAC TGAC | TGAT TGAC | -CAA ATCT | T T GCT ACT | ACA ACA TTA GTA | GTT GTT GTT GTT | GCA GCA GCA A A A A A | CTC CTC ATG ATG L M M | ATG ATG ATG ATG M M M M | TCA TCA TCA TCT S S S S | CGC CGT CGC CGC R R R R R R | CC CC CC P P P P P | | | |
|--|----------------------|-------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|--------------|------------------|----------------------|--------------------------|--------------------------|--|---|--|--|--|---|-------|-------|-----|
| Gd-DNA | Т | GTT | GCT | GGT | GTC | CGC | AAC | AAG | AGC | ATC | ATT | ATC | ACC | CTC | CCA | GGC | TCG | CCA | AAG | GGC | GC |
| Gp-DNA | Т | GTT | GCT | GGC | GTC | AGA . | AAC | AAG | AGT | ATC | ATT | ATC | ACT | CTT | CCA | GGC | TCG | CCG | AAG | GGT | GC |
| Nh-DNA | A | GTG | GCT | GGC | GTC | CGT . | AAC | CAG | ACC | ATC | ATT | GTC | ACC | TTA | ССТ | GGC | TCT | CCC | AAG | GGT | GC |
| Ac-DNA | С | GTG | GCG | GGT | GTC | AGA | GAT | AAG | TCA | CTC | CTG | ATT | ACA | CTA | CCA | GGC | TCG | CCA | AAG | GGA | GC |
| Gd-PRO | | V | A | G | V | R | N | K | S | I | I | I | Т | L | Ρ | G | S | Ρ | K | G | Α |
| Gp-PRO | | V | А | G | V | R | Ν | K | S | I | I | I | Т | L | Ρ | G | S | Ρ | Κ | G | А |
| Nh-PRO | | V | А | G | V | R | Ν | Q | Т | I | I | V | Т | L | Ρ | G | S | Ρ | K | G | Α |
| Ac-PRO | | V | A | G | V | R | D | K | S | L | L | I | Т | L | Ρ | G | S | Ρ | K | G | A |
| Gd-DNA | С | AAG | GAG | AAT | CTC | CAG | TGC | ATA | ΤΤΑ | AAG | CTC | CTA | CCT | CAT | GCA | TGC | TTG | CAA | GCA | GCA | G |
| Gp-DNA | G | AAG | GAG | AAT | CTC | CAG | TCA | GTG | CTG | AAA | CTT | CTA | CCA | CAT | GCT | TGT | TTG | CAG | GCA | GCA | G |
| Nh-DNA | С | AGG | GAG | AAT | CTC | CAG | GCC | ATC | GTC | AAG | ACT | CTT | CCT | CAT | GCT | TGC | CTC | CAG | GCG | TCA | G |
| Ac-DNA | С | AAG | GAA | AAT | CTT | GAG | GCA | ATC | ATC | AAG | CTT | CTA | CCG | CAC | GCT | TGT | ACT | CAG | GCG | GCT | G |
| Gd-PRO | | K | Ε | Ν | L | Q | C | I | L | Κ | L | L | Ρ | Η | A | С | L | Q | A | A | |
| Gp-PRO | | Κ | Ε | Ν | L | Q | S | V | L | Κ | L | L | Ρ | Η | А | С | L | Q | A | А | |
| Nh-PRO | | R | Ε | Ν | L | Q | А | I | V | K | Т | L | Ρ | Н | А | С | L | Q | А | S | |
| Ac-PRO | | K | Ε | Ν | L | E | A | I | I | K | L | L | Ρ | Η | A | С | Т | Q | A | A | |
| Gd-DNA | GG | GCG | GAC | TCC | AGA | ТСТ | СТА | CAT | GCT | GGA | GGC | ATC | C AAA | AAG | G CTG | GAA | A TCG | GAG | G GCI | r GGZ | A A |
| Gp-DNA | GΤ | GCC | GAT | TCG | AGA | TCT | CTG | CAT | GCT | GGT | GGC | ATC | C AAA | AAG | CTA | GAA | A TCG | GAG | GCI | GGC | ΞA |
| Nh-DNA | GG | GCC | AAC | TCG | AGA | TCT | CTC | CAT | GCT | GGG | GGA | GTI | ' AAG | ; AAA | СТА | GAG | TCA | GAI | GCA | A GGI | гт |
| Ac-DNA | GΑ | GCA | GAC | TCG | CGA | GCT | CTT | CAT | GCT | GGC | GGT | GTC | . AAG | , AAG | ; CTG | GAA | GCC | GAA | GC1 | GG1 | ΓG |
| Gd-PRO | G | А | D | S | R | s | L | Н | А | G | G | I | Κ | K | L | Ε | S | Е | А | G | |
| Gp-PRO | G | A | D | S | R | S | L | Η | А | G | G | I | K | K | L | Ε | S | Ε | A | G | |
| Nh-PRO | ~ | 7 | | ~ | Ð | ~ | - | | 7 | ~ | ~ | | T7 | T7 | - | - | ~ | | 7 | ~ | |
| | G | А | N | S | R | S | Ц | Н | А | G | G | | K | K | Ц | E | S | | A | G | |

| Gd-DNA | ТΑ | AGC | TCT | AGC | GGA | ТСТ | CAC | GCT | GGC | CAT | CAC | GGC | TAT | GGT | CAC | GGT | CAC | GAC | CA | 303 |
|--------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|-----|
| Gp-DNA | ΤA | GGC | TCT | GGT | GGA | GCT | CAT | GCT | GGA | CAT | CAT | GGC | CAC | AGC | CAT | GGT | CAC | GGC | CA | 318 |
| Nh-DNA | ΤA | TCA | GGT | GGA | AAG | CCC | CAA | ССТ | GCT | GCC | AGC | CAC | AGT | CAC | GGA | TGC | CAC | AGA | CA | 324 |
| Ac-DNA | ΤA | GCC | CCC | AAT | GAT | CCG | CGC | TCG | GAA | AGT | CAA | GGA | CAG | CAG | CAT | GAT | CAC | CAT | CA | 354 |
| Gd-PRO | I | S | S | S | G | S | Η | A | G | Η | Η | G | Y | G | Η | G | Η | D | | |
| Gp-PRO | I | G | S | G | G | A | Η | А | G | Η | Η | G | H | S | Η | G | Η | G | | |
| Nh-PRO | L | S | G | G | K | Ρ | Q | Ρ | A | A | S | H | S | H | G | C | Η | Η | | |
| Ac-PRO | V | A | P | N | D | Ρ | R | S | E | S | Q | G | Q | Q | Η | D | Η | Η | | |

PCS (Peroxisomal-coenzyme A synthetase): ~480 bases aligned; Alignment shows the exonic region and a predicted intronic region (Ac = Aspergillus clavatus; Ao = Arthroderma otae)

| Gp-DNA GTG CCC TTG ACA CAC A Ac-DNA GTT CCC CTG ACG CAC A Gd-PRO V P L T H | |
|--|---|
| Ac-DNA GTT CCC CTG ACG CAC A Ao-DNA GTA CCG CTC TCA CAT A Gd-PRO V P L T H | |
| Ao-DNAGTA CCG CTC TCA CAT AGd-PROV P L T H | |
| Gd-PRO V P L T H | |
| | |
| Gp-PRO V P L T H | |
| AC-PRO V P L T H | |
| Ao-PRO V P L <mark>S</mark> H | |
| Gd-DNA GG AAT TTG ACG AGG ACA ATG AGTATGCAAGCCCGCTAGTGGCTAGTGGGAGATTCTCA | |
| GP-DNA GG AAT TTG ACA AGG ACT ATG AGTATGTAAATCCGCCCGTGGGAGATTTCCA | |
| AC-DNA AG AAC CTG ACC ACT AGC ATG AGTGAGTAC-AACATCCCTGTGTGATGTAACTG | |
| AO-DNA AA AAC CTG ACC AGG ACA ATG AGTGGGTGTTGGCTAGTTTGTTGGAGATTTTTA | |
| Gd-PRO R N L T R T M | |
| GP-PRO R N L T R T M | |
| AC-PRO K N L T <mark>I</mark> S M | |
| AO-PRO K N L T R T M | |
| Gd-DNAATTGCTAA-CAATT-GACA-GAG AAC ATC CAG GCA ACA TAT GAG TTG AGC CCT | G |
| Gp-DNAATTGCTAA-CAATTTGGCA-GAG AAC ATA CAG GCA ACA TAT GAG CTG AGC CCT | G |
| AC-DNA GAAGACCACTGA-CGCGGTATCACAAGAC AAC ATC CGG GCT ACA TAT AAG TTG ACC CCC | G |
| AO-DNA TTGTCATGCTAAATACATTCTCGTTAGGA AAC ATC CAA GCT ACA TAC TCT CTG ACG GGT | А |
| Gd-PRO NIQATYELSP | |
| GP-PRO NIQATYELSP | |

| Ac-PRO | | | | | | | | | N | I | R | A | Т | Y | K | L | Т | Ρ | | |
|------------------|--------|----------|--------|--------|----------|----------|----------|--------|--------|-------------|--------|---------|------------|---------------|----------|--------|---|--|--------|--------|
| Ao-PRO | | | | | | | | | N | I | Q | A | Т | Y | S | L | т | G | | |
| | | | | | | | | | | | | | | | | | | | | _ |
| Gd-DNA | СТ | GAC | CGA . | ACC 1 | ATG | CTT | GTC | ATG | CCT | CTT | TTC | CAC | GTC | CAC | GGC | CTT | CTC | GCC | GGG | CTC |
| Gp-DNA | СТ | GAC | CGA . | ACC 2 | ATG | CTC | GTC | ATG | ССТ | CTT | TTC | CAC | GTC | CAC | GGC | CTT | CTT | GCC | GGG | TTC |
| Ac-DNA | AG | GAT | CGC . | ACC | TAC | TTG | GTG | ATG | CCT | CTA | TTC | CAC | GTC | CAC | GGG | CTG | TTG | GCC | GGA | TTC |
| Ao-DNA | ΑT | GAC | CGA . | ACT | TAT | CTT | GTT | ATG | CCG | CTC | TTC | CAC | GTC | CAC | GGG | CTT | CTC | GCC | GCT | TTC |
| Gd-PRO | A | D | R | Т | М | L | V | М | Ρ | L | F | Η | V | Η | G | L | L | A | G | L |
| Gp-PRO | A | D | R | Т | М | L | V | М | Ρ | L | F | Η | V | Η | G | L | L | A | G | F |
| Ac-PRO | E | D | R | Т | Y | L | V | М | Ρ | L | F | Η | V | Η | G | L | L | A | G | F |
| Ao-PRO | Ν | D | R | Т | Y | L | V | М | Ρ | L | F | Η | V | Н | G | L | L | A | A | F |
| Gd-DNA | CTC | GCC | CCT | CTT | CTT | TCC | GGA | GGC | тст | GTC | C GTI | r gto | с сст | GCC | C AAG | G TTC | C AGC | GCC | ACT | ' ACC |
| Gp-DNA | CTT | GCC | ССТ | СТА | CTT | TCC | GGA | GGG | TCC | GTC | C GTI | r gto | C CCI | GCC | C AAG | G TTC | C AGC | GCC | ACT | ' ACT |
| Ac-DNA | CTC | GCC | CCC | CTT | TTG | TCT | GGA | GGC | TCC | GT <i>F</i> | A ATT | r GT(| CCI | | C AGA | TTC | C TCC | GCA | TCG | GAG |
| Ao-DNA | CTC | GCC | CCG | TTA | CAG | тст | GGA | GGG | TCC | GTC | C GTT | r gto | G CCI | | C AAG | ; TTC | TCI | GCI | ACC | GAT |
| Gd-PRO | L | А | Р | L | L | S | G | G | S | V | V | V | Р | A | K | F | S | А | Т | Т |
| Gp-PRO | L | А | Ρ | L | L | S | G | G | S | V | V | V | Ρ | А | K | F | S | А | Т | Т |
| Ac-PRO | L | А | Ρ | L | L | S | G | G | S | V | I | V | Ρ | P | R | F | S | A | S | E |
| Ao-PRO | L | A | Ρ | L | Q | S | G | G | S | V | V | V | Ρ | P | K | F | S | A | Т | D |
| Gd-DNA | TTC | ТGG | GAG | GAT | ͲͲC | ATC | ACG | САТ | ΔΔΔ | GCC | AAC | T TGO | ; TAC | ACT | ' GCT | ' GTG | | ACC | АТС | CAC |
| Gn-DNA | TTC | TGG | GAA | GAC | | ATC | ААТ | TAT | AAA | GCT | | TG | ; TAC | ' ACT | ' GCT | ' GTG | | ACC | ATC | CAC |
| Ac-DNA | TTC | TGG | GCG | GAT | TTC | GTT | GGA | ттс | CAC | GCC | AA(| 2 TG(| ; TAC | : ACZ | GCT | ' GTC | CCT | ACG | ATC | CAT |
| AO-DNA | TTC | TGG | TCG | GAT | TTC | ATC | ACG | TAC | AAG | GCC | | TG | ; TAT | | GCG | GTG | | ACC | АТА | CAC |
| Gd-PRO | F | W | E | D | F | T | т Т | H | K | A | N | W | Y | т Т | A 000 | V | P | 1 1100 Т | T | H |
| Gp-PRO | - F | W | Ē | D | - न | T | N | Y | K | A | N | W | Ŷ | - Т | A | v | P | - Т | T | H |
| Ac-PRO | F | W | A | D | F | V | G | Ē | H | A | N | W | Ŷ | - T | A | v | P | T | Ī | Н |
| Ao-PRO | F | W | S | D | F | I | T | Y | K | A | N | W | Ŷ | T | A | V | P | T | I | Н |
| Cd-DNA | CAC | አመሞ | CTTC | CTTC | 707 | 770 | CCT | CCT | CCC | | | י אאר | | ' <u>אא</u> ר | י אידיי | | | • \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\ | | ' |
| Gu-DNA Cn-DNA | CAG | | CTC | CIC | AGA | AAC | CCA | CCC | | | | את י | | | י אחחת י | | | | | |
| GP-DNA | CAG | AIC | CTT | CTC | AGA | AAC | CCA | | | , ICF | | | | . AAC | | | 1 I I I 1 I I I I 1 I I I I I I I I I I | AIC | | |
| AC-DNA | CAG | AIC | CTC | CTT | AAG | | | | | | | | | | | | 1 mmc | | | |
| AU-DNA Cd-DDO | CAG | AIC T | T | T | AAG | M | UCA D | | | | | | J UCA P | | T AIC | | - TTC | | | TCT |
| GU-PRU Co-DDO | Ŷ | ⊥ т | ц т | Ц т | R D | IN NI | r D | r D | r D | 2 0 | | r. V | r P | IN NT | ⊥ т | R D | r r | ⊥ ⊤ | K D | 2 C |
| Je-PRO | Ŷ | ⊥ т | т | т | | | r D | r | r D | د ۲ | | | r P | | т Т | R D | r T | ⊥ ⊤ | л D | ی م |
| AC-PRU | Ŷ | ⊥ т | Ц т | Ц т | | | r | | r r | | r P | | r r | | ⊥ т | K P | r T | ⊥ | K D | 2 C |
| AU-PRU | Ŷ | T | Ц | Ц | <u>r</u> | п | r | E. | Ľ | С | P | 141 | P | r. | T | K | Г | V | ĸ | 5 |

| Gd-DNA | TGC | TCG | TCG | CCT | CTT | TCG | CCA | ACA | ACC | TTC | CAC | CAG | CTT | GAG | GAG | CAG | TAC | AAT | GCC | CCT | |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Gp-DNA | TGC | TCG | TCT | CCT | TTA | TCG | CCA | ACA | ACC | TTT | TAC | CAA | CTC | CAG | GAG | CAG | TAC | AAT | GCT | CCT | |
| Ac-DNA | TGC | TCA | TCG | CCG | CTG | TCG | CCA | AAG | ACT | TTC | GAG | GAT | CTG | GAA | AAG | ACG | TTC | AAG | GCC | CCC | |
| Ao-DNA | TGC | TCG | TCA | CCG | CTG | TCT | CCC | AAG | ACA | TTC | CAC | GAA | ATA | GAA | CGT | GCA | TTC | AAT | GCT | CCG | |
| Gd-PRO | С | S | S | Ρ | L | S | Ρ | Т | Т | F | Η | Q | L | Ε | Ε | Q | Y | Ν | A | Р | |
| Gp-PRO | С | S | S | Ρ | L | S | Ρ | Т | Т | F | Y | Q | L | Q | Ε | Q | Y | Ν | A | Ρ | |
| Ac-PRO | С | S | S | Ρ | L | S | Ρ | K | Т | F | E | D | L | Ε | K | Т | F | K | А | Ρ | |
| Ao-PRO | С | S | S | Ρ | L | S | Ρ | K | Т | F | Η | E | I | Ε | R | A | F | Ν | А | Ρ | |
| Gd-DNA | GTT | CTC | GAG | GCA | TAT | GCC | ATG | ACT | GAA | GCC | GCC | CAT | CAA | ATG | ACA | TCC | AGC | CCT | CTC | CCA | 484 |
| Gp-DNA | GTC | CTC | GAG | GCA | TAT | GCC | ATG | ACG | GAA | GCT | GCC | CAC | CAA | ATG | ACC | TCC | AAC | CCA | CTT | CCA | 478 |
| Ac-DNA | GTC | CTG | GAA | GCG | TAC | GCG | ATG | ACC | GAG | GCT | TCG | CAC | CAG | ATG | ACC | AGC | AAC | CCT | CTC | CCG | 486 |
| Ao-DNA | GTT | CTC | GAA | GCA | TAT | GCC | ATG | ACC | GAA | GCC | TCA | CAT | CAA | ATG | ACA | AGC | AAC | CCT | CTA | CCG | 488 |
| Gd-PRO | V | L | Ε | A | Y | А | М | Т | Ε | А | A | Η | Q | М | Т | S | S | Ρ | L | Ρ | |
| Gp-PRO | V | L | Ε | A | Y | A | М | Т | Ε | А | А | Н | Q | М | Т | S | Ν | Ρ | L | Ρ | |
| Ac-PRO | V | L | Ε | A | Y | A | М | Т | Ε | А | S | Н | Q | М | Т | S | Ν | Ρ | L | Ρ | |
| Ao-PRO | V | T, | E | Δ | Y | А | М | T | E | А | < | Н | 0 | М | т | S | Ν | P | Τ. | P | |
| | • | | - | 11 | - | | | - | - | | | | × | | - | 0 | | - | | - | |

POB3 (FACT complex subunit): \approx 400 bases aligned; The alignment starts with non-coding miscellaneous feature (Va = Verticillium albo-atrum, Gg = Glomerella graminicola)

| Gd-DNA Gp-DNA | | -CAA1 -CGA1 | TTGGC TTGGC | CGCA- CGCA- | | CCC | CTCTA FTCTA | AACCI AACGI | Г-АТ(Г-АТ(| G G | ! | FA CA FA CA | AG G AG G | GAC - GAC - | T T | TC (TC (| GAC GAC | CG CG | | | | |
|------------------|----|----------------|----------------|----------------|------|-------|----------------|----------------|----------------|--------|-------|----------------|--------------|----------------|--------|--------------|------------|----------|----|-----|-----|----|
| Va-DNA | CG | GCGAC | CACCO | CGCA- | | TCF | ATCCA | AGCT | CGAC | GCT | rcc-(| CG CA | AG G | GAC G | AG T | TC (| GAG | CG | | | | |
| Gg-DNA | СС | CAGI | TAAGI | rgggo | GGAA | GCCGA | AGCTA | AATTO | GAACA | ACCCO | GGCG | rg ca | AG G | AC - | т | AC (| GAG | CG | | | | |
| Gd-PRO | | | | | | | | | | | | Ç | 2 | D | - | F | D | R | | | | |
| Gp-PRO | | | | | | | | | | | | Ç | 2 | D | - 1 | F | D | R | | | | |
| Va-PRO | | | | | | | | | | | | Ç | 2 | D | E i | F | Ε | R | | | | |
| Gg-PRO | | | | | | | | | | | | Ç | 2 | D | - | Y | Ε | R | | | | |
| Gd-DNA | С | CTG | ACG | AAA | GTA | TTC | AAG | AAC | TGG | TAC | AGC | ACG | AAC | CTC | GAG | ACO | G AA | AG G | AG | CAC | GCA | TT |
| Gp-DNA | С | CTG | ACG | AAA | GTG | TTC | AAG | AAC | TGG | TAC | AGC | ACG | AAC | CTC | GAG | ACO | G AA | AG G | AA | CAC | GCA | TT |
| Va-DNA | С | CTG | TCG | AAG | CTC | TTC | AAA | AAC | TGG | TAC | AGC | ACG | ACC | CTC | GAG | AA | C AF | AG G | AG | CAC | GCC | СТ |
| Gg-DNA | С | CTC | GCA | AAG | ATT | TTC | AAG | AAT | TGG | TAC | AGC | ACC | GCC | CTC | GAG | AA | r af | AG G | AG | CAC | GCC | СТ |
| Gd-PRO | | L | | K | V | F | Κ | N | W | Y | S | Т | N | L | Ε | Т | k | 2 | E | Η | A | L |

| Gp-PRO | | L | Т | K | V | F | K | Ν | W | Y | S | Т | Ν | L | Ε | Т | K | Ε | Н | А | L | |
|----------------------------|---------------|---------------|---------------|----------------------|--------------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------------|---------------|-----------------|---------------|---------------|---------------|---------------|---------------|---------------|-----|-----|
| Va-PRO | | L | S | Κ | L | F | Κ | Ν | W | Y | S | Т | Т | L | Ε | Ν | Κ | Ε | Н | А | L | |
| Gg-PRO | | L | A | K | Ι | F | K | Ν | W | Y | S | Т | A | L | Ε | N | K | Ε | Η | A | L | |
| Gd-DNA | A | CGA | GGA | TGG | AAC | TGG | GGC | AAG | GCG | GAA | TTC | GGA | AAG | GCG | GAA | TTG | GCA | TTC | AAC | GTG | CA | |
| Gp-DNA | А | CGA | GGA | TGG | AAC | TGG | GGG | AAA | GCG | GAG | TTC | GGA | AAG | GCG | GAG | CTG | GCA | TTC | AAT | GTG | CA | |
| Va-DNA | G | CGC | GGC | TGG | AAC | TGG | GGC | AAG | GCG | GAG | TTC | GGC | AAG | GCT | GAG | CTG | TCC | TTC | AAC | GTG | CA | |
| Gg-DNA | G | AGA | GGA | TGG | AAC | TGG | GGC | AAG | GCC | GAA | TTC | GGA | AAG | GCC | GAG | CTT | TCC | TTC | AAC | GTC | CA | |
| Gd-PRO | | R | G | W | Ν | W | G | K | A | Ε | F | G | K | A | Ε | L | A | F | Ν | V | Q | |
| Gp-PRO | | R | G | W | Ν | W | G | K | A | Ε | F | G | K | А | Е | L | А | F | Ν | V | Q | |
| Va-PRO | | R | G | W | Ν | W | G | K | A | Ε | F | G | K | А | Ε | L | S | F | Ν | V | Q | |
| Gg-PRO | | R | G | W | Ν | W | G | K | A | Ε | F | G | K | A | Ε | L | S | F | Ν | V | Q | |
| | | | | | | | | | | | | | | | | | | | | | | |
| Gd-DNA | G | AAC | AGA | ССТ | GCG | TTT | GAG | ATC | CCC | TAC | TCG | GAG | ATC | TCG | AAT | ACG . | AAT | TTG | GCT | GGG | AA | |
| Gp-DNA | G | AAC | AGA | ССТ | GCG | TTT | GAA | ATT | CCT | TAC | TCG | GAG | ATC | TCG | AAT | ACG . | AAT | TTG | GCT | GGA | AA | |
| Va-DNA | G | AAT | CGT | CCG | GCC | TTT | GAG | GTG | CCC | TAC | TCG | GAA | ATC | TCC | AAC | ACC . | AAC | CTC | GCT | GGC | CG | |
| Gg-DNA | G | AAC | CGA | ССТ | GCT | TTT | GAA | ATC | CCT | TAC | TCC | GAG | ATC | TCA | AAT | ACC . | AAC | CTG | GCA | GGT | CG | |
| Gd-PRO | | Ν | R | Ρ | А | F | Ε | I | Ρ | Y | S | Ε | I | S | Ν | Т | Ν | L | А | G | K | |
| Gp-PRO | | Ν | R | Ρ | А | F | Ε | I | Ρ | Y | S | Ε | I | S | Ν | Т | Ν | L | А | G | K | |
| Va-PRO | | Ν | R | Ρ | А | F | Ε | V | Ρ | Y | S | Ε | I | S | Ν | Т | Ν | L | А | G | R | |
| Gg-PRO | | Ν | R | Ρ | A | F | Ε | I | Ρ | Y | S | Ε | I | S | Ν | Т | Ν | L | A | G | R | |
| Gd-DNA | G | AAC | GAG | GTG | GCG | GTT | GAG | TTC | TCG | TTG | CCG | GCT | GGT | | GGC | GAT | GAG | GGC | GCA | AAC | G | |
| Gp-DNA | G | AAC | GAG | GTG | GCA | GTC | GAG | TTT | TCG | TTG | CCG | GCG | GGT | | GGC | GAC | GAG | GGC | GCA | AAC | G | |
| Va-DNA | С | AAC | GAG | GTC | GCC | GTC | GAG | TTT | GCC | GCC | CCC | ACC | GAC | GAG | AAC | GAC | ACA | GGC | ACC | AAC | G | |
| Gg-DNA | С | AAC | GAA | GTC | GCC | GTC | GAA | TTC | TCT | GCC | CCG | ACG | GAC | CAG | AAC | GAT | ACC | GGC | ACG | AAT | G | |
| Gd-PRO | | Ν | Ε | V | А | V | Ε | F | S | L | Ρ | А | G | - | G | D | Ε | G | А | Ν | | |
| Gp-PRO | | Ν | Ε | V | А | V | Ε | F | S | L | Ρ | A | G | _ | G | D | Ε | G | A | Ν | | |
| Va-PRO | | Ν | Ε | V | А | V | Ε | F | A | A | Ρ | Т | D | E | N | D | Т | G | Т | Ν | | |
| Gg-PRO | | Ν | Ε | V | А | V | Ε | F | S | A_ | Ρ | Т | | | N _ | D | Т | G | Т | Ν | | |
| Gd-DNA | GA | AGC | TTG | GGT | GGT | GCG | AAG | GGG | ; AAG | GGG | AAG | ; AAG | GCI | GGC | GCG | GGG | AAG | GAT | CAG | TTO | G | 359 |
| Gp-DNA | GA | AGC | TTG | GGC | GGT | GCG | AAG | GGG | ; AAG | GGC | AAG | G AAG | GCC | GGC | GCA | GGG | AAG | GAT | CAA | TTA | A G | 393 |
| | | | ama | CAC | CCT | | CGI | ' GGC | : AAG | GGC | AAG | AAG | GCG | ; GGI | ' GCT | GGC | AAG | GAC | CAG | CTC | G | 459 |
| Va-DNA | GG | ACI | CIC | GAC | 001 | 000 | | | | | | | | | | | | | | | | |
| Gg-DNA | GC GC | CAC | TTG | GAC GGC | GGC | GCG | CGA | GGA | AAG | GGC | AAG | , AAG | G GCC | C GGA | GCC | GGC | AAA | GAT | CAG | СТС | G | 465 |
| Gg-DNA Gd-PRO | GC GC G | CAC S | TTG L | GGC GGC | GGC G | GCG A | CGA K | GGA | AAG K | GGC G | AAG K | G AAG K | G GCC A | G GGA | GCC A | GGC G | AAA K | GAT D | CAG Q | CTC L | C G | 465 |
| Gg-DNA Gd-PRO Gp-PRO | GC GC G | CAC S S | TTG L L | GAC GGC G G | GGC G G G | GCG A A | CGA K K | GGA G G | AAG K K | GGC G G | AAG K K | , AAG K K | GCC A A | C GGA G G | GCC A A | GGC G G | AAA K K | GAT D D | CAG Q Q | CTC L L | C G | 465 |

| Gg-PRO | | G | H | L | G | G | A | R | G | K | G | K | K | A | G | A | G | K | D | Q | L | | |
|--------|---------|-------|-------|-------|-------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|----|
| SRP72 | (Signal | reco | gnit: | ion p | arti | cle | prot | ein | 72): | ~ 4 (| 00 ba | ases | alio | gned; | Rec | gion | show | n ir | nclud | le 5[| ப ப | R and | 5□ |
| region | of the | prote | ein | (Ss = | = Scl | erot | inia | scl | erot | tior | um, i | Ad = | Ajel | llomy | vces | dern | natid | litis | 5) | | | | |
| Gd-DNA | | CTA | AAA | ΓΑΤΑΟ | CATAT | ACAT | GGAA | TGAA | ACAT | FATG | CCGC | GCATA | ATAAT | TACAT | FATGA | ATATC | CAGCT | TACI | CAAC | GTGCO | GCCCF | 1AF | |
| Ss-DNA | | GCC | CGCG | CTAGC | TCAG | CAGT | TGAT | CGCI | TTTC | GACA | CCAT | CTCCA | ATATO | CGCA | rggci | ACAG | TAAA | TAGO | GAACO | CCAT | CGCC | CTA | |
| Gp-DNA | | GGA | AGATZ | ATACA | TACA | CATG | GACT | GAAA | TAT | ATAT | GGCC' | TCGCA | ATATA | ATCA | ACAT | TATCA | GTTT | ACTO | CAAG | GCG | CTAF | ATA | |
| Ad-DNA | | TTZ | ATTC | GCCAA | CCTT | CCTT | CTTT | TTTA | ATTT(| CTTT | AAAC | AATCO | CTTTI | CGGG | GAGCO | CAGTO | GCGGC | GCCI | GAA | CAGCO | CTTC | JAA | |
| Gd-DNA | | CTC | C GC | r agc | ATG | GCG | TCC | AAC | c ccc | C AC | C GC' | I ACC | G TTC | G AGO | C AAA | A CTA | СТС | GGC | TCA | A GCA | A ACI | ΓA | |
| Ss-DNA | | GAC | G TT: | r aaa | ATG | GCC | | GAI | CAP | A ACI | A GC | A ACO | G CTC | C AGO | C GCC | C CTC | CTT | CGI | r aat | TC: | I TCI | A A | |
| Gp-DNA | | CTC | C GC | r agc | C ATG | GCG | TCC | AAC | CCC | C AC | C GC' | T AC | C TTC | G AG | C AAA | A CTC | CTC | GGC | TCA | A GCA | A ACT | ΓA | |
| Ad-DNA | | CTT | Г СТ(| C CGI | ATG | GCG | | | | - AC | C CA | g ago | C ATC | C AG | r gco | G TTG | ; GTT | CAC | G CGA | A AGO | C ACF | A A | |
| Gd-PRO | | | | | М | A | S | Ν | Ρ | Т | A | Т | L | S | Κ | L | L | G | S | A | Т | | |
| Ss-PRO | | | | | М | A | - | D | Q | Т | A | Т | L | S | A | L | L | R | N | S | S | | |
| Gp-PRO | | | | | М | А | S | N | Ρ | Т | A | Т | L | S | K | L | L | G | S | A | Т | | |
| Ad-PRO | | | | | М | A | - | - | - | Т | Q | S | I | S | A | L | V | Q | R | S | Т | | |
| Gd-DNA | | ТG | GAG | GAC | CAT | GAG | GAG | ATT | CTG | AGA | GCC | GCC | AAT | GCC | GTT | CTC | AAG | AAG | TCG | AAA | ACA | A | |
| Ss-DNA | | ΤТ | ACA | GAC | CAT | GAA | GAG | ATC | CTC | AAA | GCT | ACA | AAT | GAC | GTA | TTA | AAG | ACT | TCT | AAA | CTC | G | |
| Gp-DNA | | TC | GAT | GAC | CAC | GAG | GAG | GTT | CTG | AGA | GCC | GCC | AAT | GCT | ATT | CTC | AAG | AAG | TCG | AAA | ACA | G | |
| Ad-DNA | | TC | GAC | GAC | CAT | GAA | GAA | GTC | ATC | AAA | GCT | TGC | AAT | GCG | GTA | CTG | AAA | ACG | TCC | AAA | AAC | G | |
| Gd-PRO | | M | E | D | Η | Ε | Ε | I | L | R | A | A | Ν | А | V | L | K | K | S | Κ | Т | | |
| Ss-PRO | | I | Т | D | Η | Ε | Ε | I | L | K | А | Т | Ν | D | V | L | Κ | Т | S | Κ | L | | |
| Gp-PRO | | I | D | D | Η | Ε | Ε | V | L | R | A | A | Ν | A | I | L | K | K | S | Κ | Т | | |
| Ad-PRO | | I | D | D | Η | Ε | Ε | V | I | K | A | C | Ν | A | V | L | K | Т | S | K | N | | |
| Gd-DNA | | AC | CAG | GAT | GCG | CTG | CGT | ACT | CGC | GTT | ATT | GCA | CTC | CTC | AAG | CTA | GAC | CGC | TAC | GCA | GAT | G | |
| Ss-DNA | | AC | CCC | GAT | GCC | TTG | CAT | ACC | CGC | GCT | ATT | GCT | CTC | CTC | AAA | CTT | GAT | CGA | TTC | GAC | GAT | G | |
| Gp-DNA | | AC | CAG | GAT | GCG | СТА | CGT | ACT | CGT | GTC | ATT | GCG | CTG | CTT | AAG | CTA | GAC | CGC | TAC | GCA | GAT | G | |
| Ad-DNA | | AT | CTC | AAT | GCC | CTC | CAT | GTA | AAA | ACT | GTT | GCC | CTG | GTC | AAA | ΤTG | GAC | CGT | TTC | GAA | GAT | G | |
| Gd-PRO | | N | Q | D | A | L | R | Т | R | V | Ī | A | L | L | K | L | D | R | Y | Ā | D | | |
| Ss-PRO | | D | P | D | A | L | H | Т | R | A | I | A | L | L | K | L | D | R | F | D | D | | |
| Gp-PRO | | D | Q | D | A | L | R | Т | R | V | I | А | L | L | K | L | D | R | Y | А | D | | |
| Ad-PRO | | D | L | Ν | A | L | H | V | K | Т | V | A | L | V | Κ | L | D | R | F | E | D | | |

| Gd-DNA | CC | CTC | CGC | GCC | CTC | GAC | GAC | GGG | GGC | GAA | GCT | CTC | AGC | GAA | AGC | TGC | CAC | GTT | | |
|--|---|---|---|--|---|---|--|---|---|--|---|------------------------------------|---|------------------------------------|---|---|--|---|---|------------------|
| Ss-DNA | CA | СТА | AAA | GCC | СТС | GAC | GAA | GGT | GGA | GAT | AAA | TTG | GCT | тст | CAA | TGT | ATT | CTC | | |
| Gp-DNA | СТ | CTC | CGC | GCC | СТС | GAC | GAC | GGG | GGA | GAT | GCT | CTC | AGC | GAA | ATC | TGC | CAC | GTT | | |
| Ad-DNA | CG | ATT | CGA | GTG | ATC | GAG | GAT | GGC | GGG | GAT | GCG | CTG | AAA | AAG | AAA | GTC | CCT | CTG | | |
| Gd-PRO | А | L | R | А | L | D | D | G | G | E | A | L | S | Ε | S | С | Η | V | | |
| Ss-PRO | А | L | K | А | L | D | E | G | G | D | K | L | A | S | Q | С | I | L | | |
| Gp-PRO | А | L | R | А | L | D | D | G | G | D | A | L | S | Ε | I | С | Η | V | | |
| Ad-PRO | A | I | R | V | I | E | D | G | G | D | А | L | K | K | K | V | P | L | | |
| | | | | | | | | | | | | | | | | | | | | |
| Gd-DNA | GAG | AAG | TCG | TAC | GCC | CTT | TAC | AAA | ACA | GGC | CAG | СТС | GAG | GCC | GCA | CAC | ; AAG | ATT | TTC | G |
| Gd-DNA Ss-DNA | GAG GAA | AAG CGC | TCG GCT | TAC TAT | GCC GCT | СТТ СТС | TAC TAC | AAA AAG | ACA ACA | GGC GGG | CAC AAA | СТС СТС | GAG GCA | GCC GAT | GCA GCG | CAC GCC | ; AAC ; AAA | ATT GTA | TTC TGT | G G |
| Gd-DNA Ss-DNA Gp-DNA | GAG GAA GAG | AAG CGC AAA | TCG GCT TCG | TAC TAT TAC | GCC GCT GCG | CTT CTC CTT | TAC TAC TAC | AAA AAG AAA | ACA ACA ACA | GGC GGC GGC | CAC AAA CAA | CTC CTC CTC | GAG GCA GAG | GCC GAT GCC | GCA GCC GCA | CAC GCC | ; AAC ; AAA ; AAA | ATT GTA ATT | TTC T G T TTC | G G G |
| Gd-DNA Ss-DNA Gp-DNA Ad-DNA | GAG GAA GAG GAA | AAG CGC AAA TGG | TCG GCT TCG TCT | TAC TAT TAC TAC | GCC GCT GCG GCT | CTT CTC CTT TTA | TAC TAC TAC TAT | AAA AAG AAA AAG | ACA ACA ACA GTC | GGC GGC GGC GGC | CAC AAA CAA CAA | CTC CTC CTC | GAG GCA GAG GAA | GCC GAT GCC GAT | GCA GCA GCA GCA | GCAC GCC CAC GAT | ; AAC ; AAA ; AAA ; AAA | ATT GTA ATT CTG | TTC TGT TTC GCC | G G G G |
| Gd-DNA Ss-DNA Gp-DNA Ad-DNA Gd-PRO | GAG GAA GAG GAA E | AAG CGC AAA TGG K | TCG GCT TCG TCT S | TAC TAT TAC TAC Y | GCC GCT GCG GCT A | CTT CTC CTT TTA L | TAC TAC TAC TAT Y | AAA AAG AAA AAG K | ACA ACA ACA GTC T | GGC GGC GGC GGC G | CAC AAA CAA CAA Q | CTC CTG CTC TTA | GAG GCA GAG GAA E | GCC GAT GCC GAT A | GCZ GCZ GCZ GCZ A | CAC GCC CAC A CAC A TA Q | G AAC G AAA G AAA G AAA K | ATT GTA ATT CTG I | TTC TGT TTC GCC F | G G G G |
| Gd-DNA Ss-DNA Gp-DNA Ad-DNA Gd-PRO Ss-PRO | GAG GAA GAG GAA E E | AAG CGC AAA TGG K | TCG GCT TCG TCT S | TAC TAT TAC TAC Y Y | GCC GCT GCG GCT A A | CTT CTC CTT TTA L L | TAC TAC TAC TAC Y Y | AAA AAG AAA AAG K K | ACA ACA ACA GTC T T | GGC GGC GGC GGC G G G | CAG AAA CAA CAA Q K | CTC CTC CTC TTA L L | GAG GCA GAG GAA E A | GCC GAT GCC GAT A D | GCA GCA GCA GCA A A | CAC GCC CAC GCC CAC G ATZ Q A | G AAC G AAA G AAA G AAA K K K | GTA GTA ATT CTG I | TTC TGT TTC GCC F | G G G G |
| Gd-DNA Ss-DNA Gp-DNA Ad-DNA Gd-PRO Ss-PRO Gp-PRO | GAG GAA GAG GAA E E E | AAG CGC AAA TGG K K K | TCG GCT TCG TCT S A S | TAC TAT TAC TAC Y Y Y Y | GCC GCT GCG GCT A A A | CTT CTC CTT TTA L L L | TAC TAC TAC TAT Y Y Y Y | AAA AAG AAA AAG K K K | ACA ACA ACA GTC T T T | GGC GGC GGC GGC G G G G | CAC AAA CAA CAA Q K Q | CTC CTC CTC TTA L L | GAG GCA GAG GAA E A E | GCC GAT GCC GAT A A | GCA GCA GCA GCA A A A | $ \begin{array}{c} CAC \\ GCC \\ CAC \\ CAC \\ A \\ Q \\ Q \\ Q \\ Q \\ Q \end{array} $ | G AAC G AAA G AAA G AAA K K K K | ATT GTA ATT CTG I V I | TTC TGT TTC GCC F F F | G G G G |

VPS13 (Vacuolar protein sorting-associated protein): ~545 bases aligned (Ss = Sclerotinia sclerotiorum, Bf

= Botryotinia fuckeliana)

| Gd-DNA | GG | ATC | CCA | GAT | AGT | GGT | GGA | GCG | TTT | AGA | CTC | ACG | ATT | TAC | AGT | CCT | TAC | ATC | ATT | TTG | Α |
|--------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|-----|-----|-----|-----|-----|---|
| Gp-DNA | GΑ | ATC | CCA | GAC | GGC | GGT | GGA | GCG | TTT | AGA | CTC | ACA | ATT | TAC | AGT | CCT | TAT | GTC | ATT | TTG | Α |
| Ss-DNA | AG | ATT | CCA | GAT | AGT | GGA | GGA | GCA | TTT | AGA | GTA | ACT | GTC | TAC | AGT | CCT | TAC | GTT | ATC | СТА | Α |
| Bf-DNA | AG | ATT | CCA | GAT | AGT | GGT | GGA | GCT | TTT | AGA | GTC | ACC | GTA | TAC | AGT | CCT | TAT | GTA | ATC | СТА | А |
| Gd-PRO | | I | Ρ | D | S | G | G | A | F | R | L | T | I | Y | S | Ρ | Y | I | I | L | |
| Gp-PRO | | I | Ρ | D | G | G | G | A | F | R | L | Т | I | Y | S | Ρ | Y | V | I | L | |
| Ss-PRO | | I | Ρ | D | S | G | G | A | F | R | V | Т | V | Y | S | Ρ | Y | V | I | L | |
| Bf-PRO | | I | Ρ | D | S | G | G | A | F | R | V | Т | V | Y | S | Ρ | Y | V | I | L | |
| Gd-DNA | AT | AAA | ACT | GGC | CTG | GAT | ATC | AAT | ATC | AAG | GCC | AAG | TCG | TTA | CTG | CAG | CAA | GCA | CGG | ACG | G |
| Gp-DNA | AT | AAA | ACA | GGC | CTG | GAT | ATC | AAC | ATC | AAG | GCG | AAG | TCG | TTA | CTG | CAG | CAA | GCG | CGG | ACT | G |
| Ss-DNA | AT | AAA | ACC | GGA | CTG | GAG | ATC | AAC | ATC | AAA | CAG | AAG | TCA | TTG | ΤTG | CAG | CAA | GCA | AAG | ACG | G |
| Bf-DNA | AT | AAG | ACT | GGC | CTA | GAG | ATC | AAC | ATC | AAA | CAA | AAA | TCG | CTA | TTG | CAG | CAA | GCA | AAG | ACG | G |
| Gd-PRO | Ν | K | Т | G | L | D | I | Ν | I | ĸ | A | K | S | L | $^{-}$ L | Q | Q | А | R | Т | |
| Gp-PRO | Ν | Κ | Т | G | L | D | I | Ν | I | Κ | А | Κ | S | L | L | Q | Q | А | R | Т | |

| Ss-PRO | Ν | Κ | Т | G | L | E | I | Ν | I | K | Q | K | S | L | L | Q | Q | A | K | Т | |
|--|--|---|---|---|---|--|---|---|--|--|---|--|---|--|---|---|---|--|--|---|---|
| Bf-PRO | Ν | K | Т | G | L | E | I | Ν | I | K | Q | K | S | L | L | Q | Q | A | K | Т | |
| Gd-DNA Gp-DNA Ss-DNA | CG CA CG | GCT GCT GCC | GGC GGA GGT | CAG CAG CAA | AAG AAG GGG | GTA GTC TTT | GTG GTG CGT | CGC CGC ACA | GAT GAT GAT | CTC CTC TCG | CTT CTC GCT | GGG AGC GAT | GAT GAT TCA | GAC GAC GAA | GAA GAG CGG | CAG CAG CGT | AAG AAG AAG | GCG GCG GCA | CTG CTG CTA | CCT CCT CCT | C T T |
| BÍ-DNA | CA | GCA | GGT | CAA | GGG | TTC | CAT | ACT | GAC | TCA | GTC | GAT | TCT | GAA | CGG | CGC | AAA | GCA | CTA | CCA | Т |
| Gd-PRO | A | A | G | Q | K | V | V | R | D | L | L | G | D | D | E | Q | K | A | L | P | |
| Gp-PRO | A | A | G | Q | K | V | V | R | D | L | | S | D | D | E | Q | K | A | ட - | Р | |
| SS-PRO | A | A | G | Q | G | Ľ | R | T | D | S | A | D | S | E | R | R | K | A | ட் - | Р | |
| BI-PRO | A | A | G | Q | G | Ľ | H | - | D | S | | D | S | E | R | R | K | A | L | Р | |
| Gd-DNA | ΤG | ATG | TTT | GCG | TTC | AGT | GGC | GAC | GAC | CAG | CGC | AAC | CGC | GTC | ATC | CTC | AAA | GTC | GGC | GAG | Т |
| Gp-DNA | ΤG | ATG | TTT | GCG | TTC | AGT | GGC | GAC | GAC | CAG | CGT | AAC | CGC | GTC | ATC | CTC | AAA | GTT | GGC | GAG | Т |
| Ss-DNA | AT | ATG | TTC | GCA | TAT | GGC | GGA | GAT | GAT | CAA | AGG | AAT | CGT | GCT | ATA | ΤTG | AAG | GTT | GGC | GAC | Т |
| Bf-DNA | AC | ATG | TTC | GCG | TAT | GGC | GGA | GAT | GAT | CAA | CGA | AAT | CGT | GCT | ΤΤΑ | ATG | AAG | GTC | GGT | GAC | Т |
| Gd-PRO | L | М | F | A | F | S | G | D | D | Q | R | N | R | V | I | L | K | V | G | E | |
| Gp-PRO | L | М | F | A | F | S | G | D | D | Q | R | Ν | R | V | I | L | Κ | V | G | Ε | |
| | | ъл | - | 7 | | ~ | C | D | D | \cap | P | N | P | 7 | т | т | V | 5.7 | G | | |
| SS-PRO | Y | ΙM | E. | А | Y | G | G | D | D | Ŷ | 11 | IN | 11 | <u> </u> | 1 | Ц | L. | V | 0 | _ | |
| SS-PRO Bf-PRO | Y Y | M | F | A A | Y Y | G | G | D | D | Q | R | N | R | A | L | M | K | V V | G | D | |
| SS-PRO Bf-PRO Gd-DNA | Y CG | M M AAC | F | A A AGT | Y | G CCG | G G CAG | D D AGT | D D TTC | Q GAC | R | N N ATT | R GGC | A | L ACA | M | K GAT | V V GTG | G GTT | D | С |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA | Y CG CG | M M AAC AAC | F F TGG TGG | A A AGT AGT | Y AAA AAA | G CCG CCG | G CAG CAG | D D AGT AGT | D D TTC TTC | Q GAC GAC | R GCC GCC | N ATT ATT | R GGC GGC | A AGC AGC | L ACA ACG | M ATC ATT | K GAT GAT | V GTG GTT | G GTT GTT | D CTA CTA | C C |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA | Y CG CG CG | M M AAC AAC AAT | F F TGG TGG TGG | A A AGT AGT AGT | Y AAA AAA AAA | G CCG CCG CCA | G CAG CAG CAA | D D AGT AGT AGT | D D TTC TTC CTG | Q GAC GAC GAT | R GCC GCC GCC | N ATT ATT ATC | R GGC GGC GGT | A AGC AGC AGT | L ACA ACG AAT | M ATC ATT GTC | K GAT GAT GAT | V GTG GTT GTT | G GTT GTT GTT | D CTA CTA TTA | C C T |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA | Y CG CG CG CC | M AAC AAC AAT AAC | F F TGG TGG TGG TGG | A A AGT AGT AGT AGT | Y AAA AAA AAA AAA | G CCG CCG CCA CCG | G CAG CAG CAA CAA | D D AGT AGT AGT AGT | D D TTC TTC CTG TTG | Q GAC GAC GAT GAT | R GCC GCC GCC GCT | N ATT ATT ATC ATC | R GGC GGC GGT GGC | A AGC AGC AGT AGC | L ACA ACG AAT AAT | ATC ATT GTC GTA | K GAT GAT GAT GAT | V GTG GTT GTT GTC | G GTT GTT GTT ATA | D CTA CTA TTA TTG | C C T C |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO | Y CG CG CG CG CC S | M AAC AAC AAT AAC N | F F TGG TGG TGG TGG W | A A AGT AGT AGT AGT S | Y AAA AAA AAA AAA K | G CCG CCG CCA CCG P | G CAG CAG CAA CAA Q | D D AGT AGT AGT AGT S | D D TTC TTC CTG TTG F | Q Q GAC GAC GAT GAT D | R GCC GCC GCC GCT A | N ATT ATT ATC ATC I | R GGC GGC GGT GGC G | A AGC AGC AGT AGC S | L ACA ACG AAT AAT T | ATC ATT GTC GTA I | K GAT GAT GAT GAT D | V GTG GTT GTT GTC V | G GTT GTT GTT ATA V | D CTA CTA TTA TTG L | C C T C |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO | Y CG CG CG CC S S | M M AAC AAC AAT AAC N N | F F TGG TGG TGG TGG W W | A A AGT AGT AGT S S | Y AAA AAA AAA AAA K K K | G CCG CCG CCA CCG P P P | G CAG CAG CAA CAA Q Q | D D AGT AGT AGT AGT S S | D D TTC TTC CTG TTG F F | Q GAC GAC GAT GAT D D | R GCC GCC GCC GCT A A | N ATT ATT ATC ATC I I | R GGC GGC GGT GGC G G G | A AGC AGC AGT AGC S S | L ACA ACG AAT AAT T T | ATC ATT GTC GTA I I | K GAT GAT GAT GAT D D | V GTG GTT GTT GTC V V | G GTT GTT GTT ATA V V | D CTA CTA TTA TTG L L | C C T C |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Ss-PRO | CG CG CG CC S S S | M M AAC AAC AAT AAC N N N | F F TGG TGG TGG TGG W W W | A AGT AGT AGT AGT S S S | AAA AAA AAA AAA K K K K | G CCG CCG CCA CCG P P P P | G CAG CAG CAA CAA Q Q Q Q | D D AGT AGT AGT AGT S S S S | D D TTC TTC CTG TTG F F | Q Q GAC GAT GAT D D D D | R GCC GCC GCC GCT A A A | N ATT ATT ATC ATC I I I I | R GGC GGC GGT GGC G G G G G G | AGC AGC AGT AGC S S S S | L ACA ACG AAT AAT T T | ATC ATT GTC GTA I I V | K GAT GAT GAT D D D | V V GTG GTT GTT GTC V V V V | G GTT GTT GTT ATA V V V V | D CTA CTA TTA TTG L L L | C C T C |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Ss-PRO Bf-PRO | CG CG CG CG S S S S S | M M AAC AAC AAT AAC N N N N | F F TGG TGG TGG TGG W W W W W | A AGT AGT AGT AGT S S S S | AAA AAA AAA AAA K K K K K | G CCG CCA CCG P P P P P | G CAG CAG CAA CAA Q Q Q Q Q Q | D D AGT AGT AGT S S S S | D D TTC TTC CTG TTG F F E | Q GAC GAT GAT D D D D D | R GCC GCC GCC GCT A A A A A | N ATT ATT ATC ATC I I I I I I | R GGC GGC GGT GGC G G G G G G G G | AGC AGC AGT AGC S S S S S | L ACA ACG AAT AAT T T N | ATC ATT GTC GTA I V V | K GAT GAT GAT D D D D D | V GTG GTT GTT GTC V V V V V V V | G GTT GTT GTT ATA V V V V | D CTA TTA TTG L L L L L | C C T C |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Ss-PRO Bf-PRO Gd-DNA | CG CG CG CC S S S S CG | M M AAC AAC AAT AAC N N N N N TCA | F F TGG TGG TGG TGG W W W W W GCA | A A AGT AGT AGT S S S S S ACT | AAA AAA AAA K K K K K CAG | G CCG CCG CCG P P P P P AAT | G CAG CAG CAA CAA Q Q Q Q Q ACT | D D AGT AGT AGT S S S S S GAG | D TTC TTC CTG TTG F F E L | Q GAC GAC GAT D D D D CAT | R GCC GCC GCT A A A A GTT | N ATT ATT ATC ATC I I I I GGA | R GGC GGC GGT GGC G G G G G ATC | A AGC AGC AGT AGC S S S S AGC | L ACA ACG AAT T T N N ATC | ATC ATT GTC GTA I I V GAG | K GAT GAT GAT D D D AAT | V GTG GTT GTT GTC V V V V V GGA | G GTT GTT ATA V V V V GAC | CTA CTA TTA TTG L L L L GGG | C C T C |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Ss-PRO Bf-PRO Gd-DNA Gp-DNA | Y CG CG CG CC S S S S CG CC | M M AAC AAC AAT AAC N N N N TCA TCG | F F TGG TGG TGG TGG W W W W GCA GCA | A A AGT AGT AGT S S S S ACT ACT | AAA AAA AAA K K K K CAG CAG | G CCG CCG CCG P P P P AAT AAT | G CAG CAG CAA CAA Q Q Q Q Q ACT ACC | D AGT AGT AGT S S S S GAG GAG | D TTC TTC CTG TTG F F L L ATC ATA | Q Q GAC GAC GAT D D D D CAT CAC | R GCC GCC GCC A A A A GTT GTT | N ATT ATT ATC ATC I I I I GGA GGA | R GGC GGC GGT GGC G G G G G ATC ATC | A AGC AGC AGT AGC S S S S AGC AGT | L ACA ACG AAT T T N N ATC ATC | ATC ATT GTC GTA I I V V GAG GAG | K GAT GAT GAT D D D D AAT AAC | V GTG GTT GTT GTC V V V V GGA GGG | G GTT GTT GTT ATA V V V V U GAC GAC | CTA CTA TTA TTG L L L L GGG GGG | C C T C A A |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Ss-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA | Y CG CG CG CG CC S S S S CC CT | M M AAC AAC AAT AAC N N N TCA TCG TCT | F F TGG TGG TGG TGG W W W W GCA GCA TCT | A A AGT AGT AGT S S S S ACT ACT AAA | AAA AAA AAA K K K K CAG CAG CAG CAG | G CCG CCG CCG P P P P AAT AAT AAC | G CAG CAG CAA CAA Q Q Q Q Q Q ACT ACC | D D AGT AGT AGT S S S S GAG GAG GAG GAG | D TTC TTC TTC TTG F F L ATC ATA ATA | Q Q GAC GAC GAT D D D CAT CAC CAC | R GCC GCC GCC GCT A A A GTT GTT GTG | N ATT ATT ATC ATC I I I I GGA GGA GGC | R GGC GGC GGT GGC G G G G G ATC ATC | A AGC AGC AGT AGC S S S AGC AGT AAT | L ACA ACG AAT T T N ATC ATC ATC GTT | ATC ATT GTC GTA I I SAG GAG GAG GAA | K GAT GAT GAT D D D AAT AAC TCA | V GTG GTT GTT GTC V V V V GGA GGG GGA | G G G T T G T T A T A V V V V V V G A C G A C G A C | CTA CTA TTA L L L L GGG GGG GGG | C C T C A A A |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Ss-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA | CG GG CC CG CC SS SS CCC CT CT | M M AAC AAC AAT AAC N N N TCA TCG TCT TCC | F F TGG TGG TGG TGG W W W W GCA GCA TCT TCA | A A AGT AGT AGT S S S S ACT ACT AAA AAG | AAA AAA AAA K K K K CAG CAG CAG CAG AAC AAC | G CCG CCG CCA CCG P P P P AAT AAT AAT AAT | G CAG CAG CAA CAA Q Q Q Q Q Q ACT ACC ACC | D D AGT AGT AGT S S S S GAG GAG GAG GAG | D TTC TTC TTC TTG F F L ATC ATA ATA ATT | Q Q GAC GAC GAT D D D CAT CAC CAC CAT | R GCC GCC GCC GCT A A A A GTT GTT GTG GTA | N ATT ATT ATC ATC I I I I GGA GGC GGT | R GGC GGC GGT GGC G G G G ATC ATC ATC | A AGC AGC AGT AGC S S S AGC AGT AGT AGT | L ACA ACG AAT T T T N ATC ATC ATC GTT GTC | ATC ATT GTC GTA I I GAG GAG GAG GAA GAA | K GAT GAT GAT D D D AAT AAC TCA GCA | V GTG GTT GTT GTC V V V V GGA GGA GGA | G GTT GTT ATA V V V V GAC GAC GAG GAG | CTA CTA TTA TTG L L L GGG GGG GGG GGC GGT | C C T C A A A A A |
| SS-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Ss-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO | CG CG CG CG CG CC S S S CC CC CT P | M M AAC AAC AAC AAC N N N TCA TCG TCT TCC S | F F TGG TGG TGG TGG W W W W GCA GCA TCT TCA A | A A AGT AGT AGT S S S S ACT ACT AAA AAG T | AAA AAA AAA K K K K CAG CAG CAG CAG AAC AAC Q | G CCG CCA CCG P P P P AAT AAT AAT AAT AAT AAT | G CAG CAG CAA CAA Q Q Q Q Q ACT ACC ACC ACC | D D AGT AGT AGT S S S S GAG GAG GAG GAA E | D TTC TTC TTC TTC F F F ATC ATA ATA ATT I | Q Q GAC GAT D D D CAT CAC CAC CAT H | R GCC GCC GCC GCT A A A A GTT GTT GTG GTA V | N ATT ATT ATC ATC I I I I GGA GGC GGT G | R GGC GGC GGT GGC G G G G ATC ATC ATC I | A AGC AGC AGC S S S S AGC AGT AGT AGT S | L ACA ACG AAT T T N ATC ATC ATC GTT GTC I | ATC ATT GTC GTA I I V GAG GAG GAG GAA GAA E | K GAT GAT GAT D D D AAT AAC TCA GCA N | V GTG GTT GTT GTC V V V V GGA GGA GGA GGA GGA | G GTT GTT ATA V V V V V GAC GAC GAC GAG GAG D | CTA CTA TTA TTG L L L GGG GGG GGG GGC GGT G | C C T C A A A A A |
| SS-PRO Bf-PRO Gd-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Ss-PRO Bf-PRO Gd-DNA Gp-DNA Ss-DNA Bf-DNA Gd-PRO Gp-PRO Gp-PRO | CG CG CG CG CG CC S S S CC CT P P | M M AAC AAC AAT AAC N N N TCA TCG TCT TCC S S | F F TGG TGG TGG TGG W W W W W GCA GCA TCT TCA A A | A A AGT AGT AGT S S S S ACT ACT AAA AAG T T | AAA AAA AAA K K K K CAG CAG CAG CAG AAC Q Q Q | G CCG CCG CCA CCG P P P P AAT AAT AAT AAT AAT N N | G CAG CAG CAA CAA Q Q Q Q Q Q ACT ACC ACC ACC T T | D D AGT AGT AGT S S S S GAG GAG GAG GAA E E | D TTC TTC TTC TTG F F E ATC ATA ATA ATA I I | Q GAC GAC GAT D D D D CAT CAC CAC CAT H H | R GCC GCC GCC GCC A A A A GTT GTT GTG GTA V V | N ATT ATT ATC ATC I I I I GGA GGC GGT G G | R GGC GGC GGT GGC G G G G ATC ATC ATC ATC I I | A AGC AGT AGC S S S S AGC AGT AGT S S S | L ACA ACG AAT T T N ATC ATC GTT GTC I I | ATC ATT GTC GTA I I GAG GAG GAA GAA E E | K GAT GAT GAT D D D AAT AAC TCA GCA N N | V GTG GTT GTT GTC V V V V V GGA GGG GGA GGA G G | G GTT GTT ATA V V V V V GAC GAC GAC GAC GAC D D | CTA CTA TTG L L L GGGG GGGC GGC GGT G G | C C T C A A A A A |

| BÉ-PRO PS <mark>SK</mark> NNTEIHVGIS <mark>V</mark> | Ε | A | G | E | G | |
|---|-------|-----|-----|------------|-----|---|
| Gd-DNA AA TAC AAG ATG ACC AAG GTC GTT ACG CTT GCG CCG AGA TTT GT | G CTG | AAG | AAT | CGC | ATG | А |
| Gp-DNA AA TAC AAG ATG ACC AAG GTC GTT ACG CTT GCA CCG AGA TTT GT | G CTG | AAG | AAT | CGC | ATG | А |
| SS-DNA AA TAC AAA ATG ACG AAG GTA GTC ACT CTT GCT CCC OGC TTC GT | Г CTG | AAG | AAT | CAG | ATG | А |
| BEDNA AA TAT AAG ATG ACG AAG GTT GTC ACA CTT GCT CCT CGC TTT GT | T TTA | AAG | AAT | CAA | ATG | А |
| Gd-PRO KYKMTKVVTLAPRFV | L | K | Ν | R | М | |
| GP-PROKYKMTKVVTLAPRFV | L | K | Ν | R | М | |
| ŚŚ-PROKYKMTKVVTLAPRFV | L | K | Ν | \bigcirc | М | |
| BF-PROKYKMTKVVTLAPRFV | L | K | Ν | Q | М | |
| | | | | | | |
| Gd-DNA GC GAG GAA ATC AGC GCC AGG GAA CCT GGA TCG TCG GAG CTT ATC | G ACT | TTG | AAG | CGG | GGA | G |
| GP-DNA GT GAG GAA ATC AGC GCC AGG GAA CCT GGA TCG TCG GAG CTC ATC | G ACT | TTG | AAG | CCG | GGA | G |
| SS-DNA AC GAG GAA ATA AAT GTC AGG GAA CCC GGG TCG TCT GAA CTC TG | G ACT | TTG | AAG | CCA | CAG | G |
| BF-DNA GC GAA GAA CTA AAC GTT AGA GAG CCT GGG TCA TCT GAA CTT TG | G ACT | TTG | AAG | CCA | CAA | G |
| Gd-PRO SEEISAREPGSSELM | Т | L | Κ | R | G | |
| GP-PRO SEEISAREPGSSELM | Т | L | Κ | Ρ | G | |
| SS-PRO NEEINVREPGSSELW | Т | L | Κ | Р | Q | |
| BF-PRO SEE NVREPGSSELW | Т | L | K | Ρ | Q | |
| Gd-DNA AA CTG AAG GCT CTT CAC TTC CTT CAA AAG TCG GCG GTT AAG CA | A CTG | TGC | CTT | TGC | TTC | С |
| GP-DNA AA CTG AAA GCT CTT CAC TTC CTT CAA AAG TCG GCG GTG AAG CAJ | A CTG | TGC | CTT | TGC | TTC | С |
| SS-DNA CC CTA GAA CCT CTT CAT TTC CTC CAG AAG AGT CCC GTC AAG CAJ | A CTT | ACG | СТА | TGC | TTC | С |
| BF-DNA CT TTA GAG CCT CTT CAT TTC CTT CAG AAG AGT CAT GTA AAA CAJ | А СТС | ACG | ATG | TGC | TTC | С |
| Gd-PRO ELKALHFLQKSAVKQ | L | С | L | С | F | |
| GP-PRO ELKALHFLQKSAVKQ | L | С | L | С | F | |
| SS-PRO ALE PLHFLQKS PVKQ | L | Т | L | С | F | |
| BF-PRO AL PLHFLQKSHVKQ | L | Т | Μ | С | F | |
| Gd-DNA CC GGC | | | | | | |
| Gp-DNA CG GGC | | | | | | |
| Ss-DNA CT GGA | | | | | | |
| BÉ-DNA CA GGA | | | | | | |
| | | | | | | |
| GG-PRO P G | | | | | | |
| GG-PRO P G Gp-PRO P G | | | | | | |
| Ga-PROPGGp-PROPGSs-PROPG | | | | | | |