name	sequence
GrxS12 for	5’ CCCCCCATGGCTTCCTTTGGGTCCAGGCTC 3’
GrxS12 rev	5’ CCCCGGATCCTTAGCCCTGTGACTTTTTAGC 3’.
GrxS12 W28Y for	5’ GTTTACTCCAAAACT**TAC**TGTTCGTATTCTTCT 3’
GrxS12 W28Y rev	5’ AGAAGAATACGAACA**GTA**AGTTTTGGAGTAAAC 3’
GrxS12 C29S for	5’ TACTCCAAAACTTGG**AGC**TCGTATTCTTCTGAG 3’
GrxS12 C29S rev	5’ CTCAGAAGAATACGA**GCT**CCAAGTTTTGGAGTA-3’
GrxS12 C87S for	5’ AAACATATTGGTGGC**AGC**ACAGATACTGTGAAA 3’
GrxS12 C87S rev	5’ TTTCACAGTATCTGT**GCT**GCCACCAATATGTTT 3’
GrxS12 YCGYC for	5’ GTAGTTTACTCCAAAACT**TAC**TGT**GGG**TAT**TGTTTT**GAGGTGAAGTCTTTG 3’
GrxS12 YCGYC rev	5’ CAAAGACTTCACCTC**AAAACA**ATA**CCC**ACA**GTA**AGTTTTGGAGTAAACTAC 3’
GrxS12 pCK for	5’ CCCCCCATGGCAGACACACTCACAAAT 3’
GrxS12 pCK rev	5’ CCCCGGATCCACTACAACTGGGTTCTCAGC 3’

Supplementary Table 1: **Primers used in this study.**
The *Nco*I and *Bam*HI cloning restriction sites are underlined in the primers. The mutagenic codons are in bold.

Helices residues	**α1**	**α1’**	**α2**	**α3**	**α4**
	5 – 19	31 – 44	58 – 69	87 – 95	98 – 107
β-Strands Residues	**β1**	**β2**	**β3**	**β4**	
	21 – 25	47 – 51	76 – 80	82 – 85	

Supplementary Table 2: **Secondary structure elements of poplar GrxS12.**

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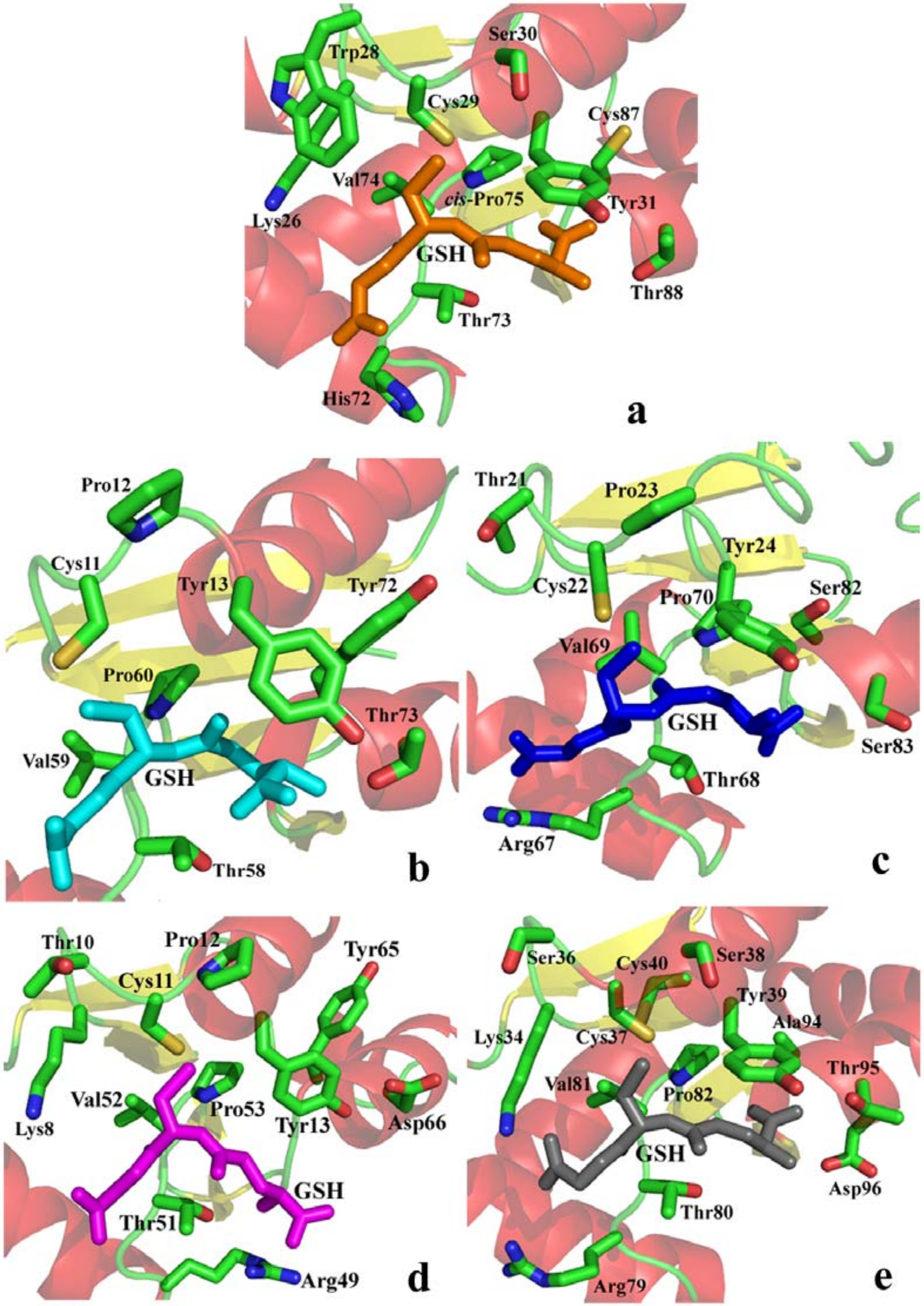
At    69 SSGSTLEETVKTTVAENPVVVYSKTWCSYSSQVKSLFKSLQVEPLVVELDQLGSEGSQLQNVLEKITGQYTVPNVFIGGKHIGGCSDTLQLHNKGELEAILAEANGKNGQT 179
Ptt   75 SFGSRLEDAVKKTVAENPVVVYSKTWCSYSSEVKSLFKRLNVDPLVVELDELGAQGPQIQKVLERLTGQHTVPNVFIGGKHIGGCTDTVKLYRKGELEPLLSEANAKKSQG 185
Pp    54 SFGSRLEESVKKTVDENPVVVYSKTWCSYSSEVKSLFKRLGVEPMVIELDELGPQGPQLQKVLERLTGQHTVPNVFIAGKHIGGCTDTVKLYRKGELEPLLSEAKAKNAQS 164
Md    70 SFGSRLEESVKKTVDENPVVVYSKTWCSYSSEVKTLFKRLDVEPIVIELDELGPQGPQLQKVLERLTGQHTVPNVFIGGKHIGGCTDTVKLYRTGELETLLSEASAKNTQS 180
Cp    73 SFGSRLEESVKKTVADNTVVVYSKTWCSYSSEVKILFKRLGVEPLVIELDELGAQGPQLQKVLERLTGQHTVPNVFIGGKHIGGCTDTIKLYRKGELETLLSEANAKNIQS 183
Cs    66 SYGSRLEESVKKTVSENPVVVYSKTWCSYSSEVKLLFKRLGVEPLVIELDEMGPQGPQLQKLLERLTGQHTVPNVFIGGKHIGGCTDTVKLYRKGELEPLLSEAKSAEN-- 174
Pt    66 SFGSRLEESVKKTVSENPVVVYSKTWCSYSSEVKLLFKRLGVEPLVIELDEMGPQGPQLQKLLERLTGQHTVPNVFIGGKHIGGCTDTVKLYRKGELEPLLSEAKSAEN-- 174
Cr    68 SFGSRLEESVKKTVTDNPVVVYSKTWCSYSSEVKSLFKRLDVEPLVIELDQLGPQGPQLQKVLERLTGQHTVPNVFIGGKHIGGCTDTVKLHRKGDLEPLLSKASAKKTES 178
In    75 SFGSRMEESVKRTVGENPVVVYSKTWCSYSSEVKVLFKRLGVEPLVIELDEMGPQGPQLQKVLERLTGQHTVPNVFIGGKHIGGCTDTIKLYRKGELEPLLSEASARKTES 185
St    73 SFGSRLEESVKKTITENPVVVYSKSWCSYSTEVKVLFKRLGVDPLVIELDEMGPQGPQLQKVLERLTGQHTVPNVFIGAKHIGGCTDTIKLYRKGELESLLSEAKAGKTES 183
Nt    70 SFGSRLEESVKKTITENPVVVYSKTWCSYSMEVKALFKKLGVDPLVIELDEMGPQGPQLQKVLERLTGQHTVPNVFIGAKHIGGCTDTIKLYRKGELEPLLSEANAGKTES 180
Vv    69 SFGSRLEETVKKTVEENPVVVYSKTWCSYSSEVKSLFKRLGVEPFVIELDEMGPQGPQLQKVLERLTGQHTVPNVFIGGKHIGGCTDTVKLYRKGELEPLLSEASTRKTES 179
Cm    74 SFGSRLEESVKTTITQNPVVVYSKTWCSYSSEVKALFKRLGVQPLVIELDELGPQGPQLQKVLERLTGQHTVPNVFIGGKHIGGCTDTVKLYRKGELELMLSEANAKHSEA 184
La    58 SFGSRLEETIKKTVSDNPVVVYSKTWCSYSSEVKSLFKKLGADPLVFELDEMGAQGPQLQKVLERLTGQHTVPNVFIGGQHIGGCTDTLKLYRNGELEPLLSKAKAKNT-- 166
Gm    56 SFGSRLEDTIKKTVAENPVVVYSKTWCTYSSEVKILFKKLGVDPLVFELDEMGPQGPQLQKVLERITGQHTVPNVFIGGKHIGGCTDTLKLYRKGELEPLLSEANAKKTES 166
Os    54 SFGSRMEDSVKRTLADNPVVIYSKSWCSYSMEVKALFKRIGVQPHVIELDQLGAQGPQLQKVLERLTGQSTVPNVFIGGKHIGGCTDTVKLHRKGELATMLSELDIDVNNS 164
Sb    60 SFGSRMEDSVKKTVADNPVVIYSKSWCSYSMEVKALFKRIGVQPHVIELDHLGAQGPQLQKVLERLTGQTTVPNVFIGGKHVGGCTDTVKLYRKGELASMLSDLDININNS 170
Zm    57 SFGSRMEDSVKKTVADNPVVIYSKSWCSYSMEVKSLFKRIGVQPHVIELDNLGAQGPQLQKVLERLTGQSTVPNVFIGGKHVGGCTDTVKLYRKGELASMLSDLDINIDNS 167
Gh    59 SFGSRLEESVKKTVASNPVVVYSKSWCSYSSEVKSLFKKLGVEPLVIELDEMGAQGPQVQKLLERLTGQHTVPNVFIGGKHIGGCTDTVKLYRRGELEPLLSEATAKSKEN 169
```

α1 β1 α1′ β2 α2 β3 β4 α3 α4

Supplementary Figure 2



Supplementary Figure 3