

# Glycosyltransferase-mediated Sweet Modification in Oral Streptococci

Journal of Dental Research  
DSI-DS2  
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for Dental Research 2015  
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DOI: 10.1177/0022034515574865  
jdr.sagepub.com

F. Zhu<sup>1</sup>, H. Zhang<sup>1</sup>, and H. Wu<sup>1</sup>

## Appendix

**Table.** Glycosyltransferases Exist in Oral and Other Related Bacteria.

	Enzyme Name	Species	Donor	Acceptor	GT	Fold	Localization	Reference
GTs important for modification of SRRPs	Gtf1/2	<i>Streptococcus parasanguinis</i>	UDP-GlcNAc	FapI	GT1	GT-B	Intracellular and membrane associated	Wu et al. 2010; Wu and Wu 2011
	Gtf3	<i>S. parasanguinis</i>	UDP-Glc	FapI-GlcNAc	GT1	GT-B	Intracellular	Zhou et al. 2010; Zhu et al. 2011
	DUF1972	<i>S. parasanguinis</i>	UDP-Glc	FapI-GlcNAc-Glc		GT-D	Intracellular	Zhang et al. 2014
	GalT2, Gly	<i>S. parasanguinis</i>	TBD	FapI-GlcNAc-Glc-Glc	GT2	GT-A	Intracellular	Zhang et al. 2014
	GtfA/B	<i>Streptococcus pneumoniae</i>	UDP-GlcNAc	Psrp	GT1	GT-B	TBD	Shi et al. 2014
	GtfC	<i>Streptococcus agalactiae</i>	UDP-Glc	Srr2	GT1	GT-B	TBD	Zhu et al. 2015
	GtfA/B	<i>Streptococcus gordonii</i>		GspB			Intracellular	Takamatsu et al. 2004
	GtfA/B	<i>Staphylococcus aureus</i>	UDP-GlcNAc	SraP	GT1	GT-B	TBD	Li et al. 2014
GTFs important for glucan synthesis	GtfB	<i>Streptococcus mutans</i>					Extracellular	Bowen and Koo 2011
	GtfC	<i>S. mutans</i>			GH70		Extracellular	Ito et al. 2011
	GtfD	<i>S. mutans</i>					Extracellular	Bowen and Koo 2011
	GtfG	<i>Streptococcus gordonii</i>					Extracellular	Vickerman et al. 1996
	GtfR	<i>Streptococcus oralis</i>			GH70		Extracellular	Hellmuth et al. 2008
	GTFs	<i>Streptococcus sobrinus</i>					Extracellular	Colby and Russell 1997
GTs found in other oral bacteria	Fnu_GT	<i>Fusobacterium nucleatum</i>	TBD	TBD	GT2	GT-A	TBD	Kim et al. 2008
	GtfA	<i>Porphyromonas gingivalis</i>	TBD	TBD	GT2	GT-A	TBD	Narimatsu et al. 2004
	PGN_1251	<i>P. gingivalis</i>	TBD	TBD	GT1	GT-B	TBD	Yamaguchi et al. 2010
	PG0106	<i>P. gingivalis</i>	TBD	TBD	GT4		TBD	Davey and Duncan 2006
	VimF	<i>P. gingivalis</i>	TBD	TBD	GT1	GTB	TBD	Vanterpool et al. 2005

GT, glycosyltransferase; GTF, glucosyltransferase; SRRP, serine-rich repeat protein; TBD, to be determined.

<sup>1</sup>Departments of Microbiology and Pediatric Dentistry, Schools of Dentistry and Medicine, University of Alabama at Birmingham, Birmingham, AL, USA

**Corresponding Author:**

H. Wu, SDB 802, School of Dentistry Building, Department of Pediatric Dentistry, Schools of Dentistry, University of Alabama at Birmingham, Birmingham, AL 35294, USA.  
Email: hwu@uab.edu

## Appendix References

- Bowen WH, Koo H. 2011. Biology of *Streptococcus mutans*-derived glycosyltransferases: role in extracellular matrix formation of cariogenic biofilms. *Caries Res.* 45(1):69–86.
- Colby SM, Russell RR. 1997. Sugar metabolism by mutans streptococci. *Soc Appl Bacteriol Symp Ser.* 26:80S–88S.
- Davey ME, Duncan MJ. 2006. Enhanced biofilm formation and loss of capsule synthesis: deletion of a putative glycosyltransferase in *Porphyromonas gingivalis*. *J Bacteriol.* 188(15):5510–5523.
- Hellmuth H, Wittrock S, Kralj S, Dijkhuizen L, Hofer B, Seibel J. 2008. Engineering the glucansucrase GTFR enzyme reaction and glycosidic bond specificity: toward tailor-made polymer and oligosaccharide products. *Biochemistry.* 47(25):6678–6684.
- Ito K, Ito S, Shimamura T, Weyand S, Kawarasaki Y, Misaka T, Abe K, Kobayashi T, Cameron AD, Iwata S. 2011. Crystal structure of glucansucrase from the dental caries pathogen *Streptococcus mutans*. *J Mol Biol.* 408(2):177–186.
- Kim S, Oh DB, Kwon O, Jung JG, Lee YM, Ko K, Ko JH, Kang HA. 2008. Biochemical characterization of a glycosyltransferase homolog from an oral pathogen *Fusobacterium nucleatum* as a human glycan-modifying enzyme. *J Microbiol Biotechnol* 18(5):859–865.
- Li Y, Huang X, Li J, Zeng J, Zhu F, Fan W, Hu L. 2014. Both GtfA and GtfB are required for SraP glycosylation in *Staphylococcus aureus*. *Curr Microbiol.* 69(2):121–126.
- Narimatsu M, Noiri Y, Itoh S, Noguchi N, Kawahara T, Ebisu S. 2004. Essential role for the *gtfA* gene encoding a putative glycosyltransferase in the adherence of *Porphyromonas gingivalis*. *Infect Immun.* 72(5):2698–2702.
- Shi WW, Jiang YL, Zhu F, Yang YH, Shao QY, Yang HB, Ren YM, Wu H, Chen Y, Zhou CZ. 2014. Structure of a novel O-linked N-acetyl-d-glucosamine (O-GlcNAc) transferase, GtfA, reveals insights into the glycosylation of pneumococcal serine-rich repeat adhesins. *J Biol Chem.* 289(30):20898–20907.
- Takamatsu D, Bensing BA, Sullam PM. 2004. Four proteins encoded in the *gspB-secY2A2* operon of *Streptococcus gordonii* mediate the intracellular glycosylation of the platelet-binding protein GspB. *J Bacteriol.* 186(21):7100–7111.
- Vanterpool E, Roy F, Fletcher HM. 2005. Inactivation of *vimF*, a putative glycosyltransferase gene downstream of *vimE*, alters glycosylation and activation of the gingipains in *Porphyromonas gingivalis* W83. *Infect Immun.* 73(7):3971–3982.
- Vickerman MM, Sulavik MC, Minick PE, Clewell DB. 1996. Changes in the carboxyl-terminal repeat region affect extracellular activity and glucan products of *Streptococcus gordonii* glycosyltransferase. *Infect Immun.* 64(12):5117–5128.
- Wu R, Wu H. 2011. A molecular chaperone mediates a two-protein enzyme complex and glycosylation of serine-rich streptococcal adhesins. *J Biol Chem.* 286(40):34923–34931.
- Wu R, Zhou M, Wu H. 2010. Purification and characterization of an active N-acetylglucosaminyltransferase enzyme complex from *Streptococci*. *Appl Environ Microbiol.* 76(24):7966–7971.
- Yamaguchi M, Sato K, Yukitake H, Noiri Y, Ebisu S, Nakayama K. 2010. A *Porphyromonas gingivalis* mutant defective in a putative glycosyltransferase exhibits defective biosynthesis of the polysaccharide portions of lipopolysaccharide, decreased gingipain activities, strong autoaggregation, and increased biofilm formation. *Infect Immun.* 78(9):3801–3812.
- Zhang H, Zhu F, Yang T, Ding L, Zhou M, Li J, Haslam SM, Dell A, Erlandsen H, Wu H. 2014. The highly conserved domain of unknown function 1792 has a distinct glycosyltransferase fold. *Nat Commun.* 5:4339.
- Zhou M, Zhu F, Dong S, Pritchard DG, Wu H. 2010. A novel glycosyltransferase is required for glycosylation of a serine-rich adhesin and biofilm formation by *Streptococcus parasanguinis*. *J Biol Chem.* 285(16):12140–12148.
- Zhu F, Erlandsen H, Ding L, Li J, Huang Y, Zhou M, Liang X, Ma J, Wu H. 2011. Structural and functional analysis of a new subfamily of glycosyltransferases required for glycosylation of serine-rich streptococcal adhesins. *J Biol Chem.* 286(30):27048–27057.
- Zhu F, Zhang H, Wu H. 2015. A conserved domain is crucial for acceptor substrate binding in a family of glycosyltransferases. *J Bacteriol.* 197(3):510–517.