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## Synthetic methods to glycerol teichoic acids

Hogendorf, W.F.J.

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**Author:** Hogendorf, Wouter Frederik Johan

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# **Synthetic Methods to Glycerol Teichoic Acids**

PROEFSCHRIFT

ter verkrijging van  
de graad van Doctor aan de Universiteit Leiden,  
op gezag van Rector Magnificus prof. mr. P.F. van der Heijden  
volgens besluit van het College voor Promoties  
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door

**Wouter Frederik Johan Hogendorf**

Geboren te Leiden in 1983

# Promotiecommissie

Promotor: Prof. Dr. G.A. van der Marel

Co-promotores: Dr. J.D.C. Codée  
Dr. D.V. Filippov

Overige Leden: Prof. Dr. H.S. Overkleeft  
Prof. Dr. J. Brouwer  
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*"If you want a happy ending, that depends,  
of course, on where you stop your story."*

Orson Welles

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# List of Abbreviations

5-BTT	5-benzylthio-1 <i>H</i> -tetrazole	ELISA	enzyme-linked immunosorbent assay
Å	Angstrom	ESI	electro spray ionization
Ac	acetyl	Et	ethyl
Ala	alanyl	eq	molar equivalents
All	allyl	Fmoc	Fluorenylmethyloxycarbonyl
ATP	adenosine triphosphate	F-Msc	[1 <i>H</i> ,1 <i>H</i> ,2 <i>H</i> ,2 <i>H</i> ]-perfluorodecylsulfonyl Ethoxycarbonyl
BOM	benzyloxymethyl	F-Psc	perfluorooctylpropylsulfonylethoxy carbonyl
BOP	benzotriazol-1-yl-oxy-tris- (dimethylamino)phosphonium hexafluorophosphate	F-Pse	perfluorooctylpropylsulfonyl ethyl
bs	broad singlet	F-SPE	fluorous solid phase extraction
BSA	bovine serum albumin	Glc	glucose
Bt	benzotriazole	GlcNAc	<i>N</i> -acetyl glucosamine
Bz	benzoyl	GTA	glycerol teichoic acid
CAN	Ceric ammonium nitrate	h	hour(s)
Cbz	carboxybenzyl	HEK	human embryonic kidney
CDP	cytidine diphosphate	HiB	<i>Haemophilus influenza</i> type b
CE	2-cyanoethyl	HIC	hydrophobic interaction chromatography
CFU	colony forming unit	HOBT	hydroxybenzotriazole
COD	1,5-cyclooctadiene	HP	high performance
COSY	correlation spectroscopy	HPLC	high performance liquid chromatography
CP	capsular polysaccharide	HRMS	high resolution mass spectrometry
CPG	controlled pore glass	HSQC	heteronuclear single quantum coherence
δ	chemical shift	Hz	hertz
d	doublet	i.v.	intravenously
DCA	dichloroacetic acid	Ig	immunoglobulin
dd	doublet of doublets	IL	interleukin
ddd	doublet of doublet of doublets	Im	imidazole
DDQ	2,3-dichloro-4,5-dicyano-1,4- benzoquinone	<i>i</i> Pr	isopropyl
DBU	1,8-diazabicyclo[5.4.0]undec-7-ene	IR	infrared
DC	dual color	<i>J</i>	coupling constant
DCC	<i>N,N'</i> -dicyclohexylcarbodiimide	kDa	kilodalton
DCM	dichloromethane	KLH	keyhole limpet hemocyanin
DCE	1,2-dichloroethane	LCMS	liquid chromatography – mass spectrometry
DCI	4,5-dicyanoimidazole	LPS	lipopolysaccharide
DIC	<i>N,N'</i> -diisopropylcarbodiimide	LTA	lipoteichoic acid
DiPEA	<i>N,N</i> -diisopropylethylamine	m	multiplet
DMAP	4-dimethylaminopyridine	<i>m</i> -CPBA	<i>meta</i> -chloroperbenzoic acid
DMF	dimethylformamide	Me	methyl
DMT	4,4'-dimethoxytrityl	min	minutes
DNA	deoxyribonucleic acid	MMT	4-methoxytrityl
DTd	diphtheria toxoid	MS	molecular sieves
DTT	dithiothreitol		
EDCI	1-ethyl-3-(3-dimethylaminopropyl) carbodiimide		

## List of Abbreviations

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<i>m/z</i>	mass-to-charge ratio	SDS	sodium dodecyl sulfate
NMI	<i>N</i> -methylimidazole	sn	stereospecific numbering
NMR	nuclear magnetic resonance	t	triplet
NRS	normal rabbit serum	TA	teichoic acid
OPA	opsonophagocytic assay	<i>t</i> Bu	<i>tert</i> -butyl
OPIA	opsonophagocytic inhibition assay	TBAF	tetrabutylammonium fluoride
PAB	<i>para</i> -azidobenzyl	TBAI	tetrabutylammonium iodide
PAGE	polyacrylamine gel electrophoresis	TBDPS	<i>tert</i> -butyl-diphenylsilyl
PBS	phosphate buffer saline	TCA	trichloroacetic acid
PE	petroleum ether	TES	triethylsilane
PEG	polyethylene glycol	TFA	trifluoroacetic acid
Ph	phenyl	TfOH	trifluoromethanesulfonic acid
Phth	phthaloyl	Tf <sub>2</sub> O	trifluoromethanesulfonic anhydride
Piv	pivaloyl	THF	tetrahydrofuran
PMB	<i>para</i> -methoxy benzyl	TLC	thin liquid chromatography
PPTS	pyridinium <i>para</i> -toluene sulfonate	TLR	Toll-like receptor
pTsOH	<i>para</i> -toluenesulfonic acid	TMS	trimethylsilyl
pyBOP	benzotriazol-1-yl- oxytripyrrolidinophosphonium hexafluorophosphate	TNF- $\alpha$	tumor necrosis factor alpha
pyr	pyridine	TPSNT	triisopropylphenylsulfonyl nitrotriazolate
q	quartet	Ts	<i>para</i> -toluenesulfonyl
RNA	ribonucleic acid	TTBP	2,4,6-tris( <i>tert</i> -butyl)pyrimidine
RP	reversed phase	TTd	tetanus toxoid
RT	room temperature	UDP	uridine diphosphate
r.t.	room temperature	UV	ultraviolet
s	singlet	WBC	white blood cell
s.c.	subcutaneously	WTA	wall teichoic acid