University of Groningen

The role of the gaseous signaling molecule hydrogen sulfide in chronic liver disease

Damba, Turtushikh

DOI:
[10.33612/diss.131759040](https://doi.org/10.33612/diss.131759040)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2020

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):
Damba, T. (2020). *The role of the gaseous signaling molecule hydrogen sulfide in chronic liver disease: Special emphasis on non-alcoholic fatty liver disease*. [Thesis fully internal (DIV), University of Groningen]. University of Groningen. <https://doi.org/10.33612/diss.131759040>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

The role of the gaseous signaling molecule hydrogen sulfide in chronic liver disease

Special emphasis on non-alcoholic fatty liver disease

Turtushikh Damba

This work was funded by Mongolian State Training fund and Groningen University Institute for Drug Exploration (GUIDE), Graduate School of Medical Sciences (GSMS), University Medical Center Groningen, University of Groningen, Groningen, the Netherlands.

The printing of thesis was financially supported by the following organizations:

Graduate School of Medical Sciences
Nederlandse vereniging voor Hepatologie (NVH)
Centre for East Asian Studies Groningen (CEASG)

The authors gratefully acknowledges the financial support for printing of this thesis

Front cover design: Reber Ira-P
Layout design: Rianne Jongman (rianne_jongman@hotmail.com)
Printed by: Gildeprint, Enschede, the Netherlands

© copyright 2020 Turtushikh Damba

All right reserved. No parts of this publication may be reproduced, stored on retrieval system, or transmitter in any form or by any means, without the permission of the author.

**university of
 groningen**

The role of the gaseous signaling molecule hydrogen sulfide in chronic liver disease

Special emphasis on non-alcoholic fatty liver disease

PhD thesis

to obtain the degree of PhD at the
University of Groningen
on the authority of the
Rector Magnificus Prof. C. Wijmenga
and in accordance with
the decision by the College of Deans.

This thesis will be defended in public on

Monday 7th of September 2020 at 14:30 hours

by

Turtushikh Damba

born on 17 March 1988
in Ulaanbaatar, Mongolia

Promotores

Prof. dr. A.J. Moshage

Prof. dr. H. van Goor

Assessment committee

Prof. dr. Rob Henning

Prof. dr. Peter Olinga

Prof. dr. Jonel Trebicka

Paranimfen

F.A. Aguilar Mora

M. Zhang

Dedicated to my mother and my family for all their love and sacrifices

Contents

Chapter 1	General introduction and scope of the thesis	9
Chapter 2	Role of gasotransmitter hydrogen sulfide (H ₂ S) on free fatty acids metabolism during progression of steatosis	31
Chapter 3	Oxidative Stress Is Associated with Suspected Non-Alcoholic Fatty Liver Disease and All-Cause Mortality in the General Population	51
Chapter 4	Hydrogen sulfide stimulates activation of hepatic stellate cells through increased cellular bio-energetics	77
Chapter 5	Inhibition of endogenous hydrogen sulfide reduces hepatic stellate cells activation via induction of cellular senescence	97
Chapter 6	Bioactive coumarin-derivative esculetin decreases hepatic stellate cell activation via induction of cellular senescence via the PI3K-Akt-GSK3 β pathway	117
Chapter 7	General discussion and future perspectives	141
Appendices	Abbreviations	156
	Summary and Nederlandse Samenvatting	159
	Author affiliations	163
	Acknowledgements	164
	Biography	168