Springer Theses

Recognizing Outstanding Ph.D. Research

Aims and Scope

The series "Springer Theses" brings together a selection of the very best Ph.D. theses from around the world and across the physical sciences. Nominated and endorsed by two recognized specialists, each published volume has been selected for its scientific excellence and the high impact of its contents for the pertinent field of research. For greater accessibility to non-specialists, the published versions include an extended introduction, as well as a foreword by the student's supervisor explaining the special relevance of the work for the field. As a whole, the series will provide a valuable resource both for newcomers to the research fields described, and for other scientists seeking detailed background information on special questions. Finally, it provides an accredited documentation of the valuable contributions made by today's younger generation of scientists.

Theses are accepted into the series by invited nomination only and must fulfill all of the following criteria

- They must be written in good English.
- The topic should fall within the confines of Chemistry, Physics, Earth Sciences, Engineering and related interdisciplinary fields such as Materials, Nanoscience, Chemical Engineering, Complex Systems and Biophysics.
- The work reported in the thesis must represent a significant scientific advance.
- If the thesis includes previously published material, permission to reproduce this must be gained from the respective copyright holder.
- They must have been examined and passed during the 12 months prior to nomination.
- Each thesis should include a foreword by the supervisor outlining the significance of its content.
- The theses should have a clearly defined structure including an introduction accessible to scientists not expert in that particular field.

More information about this series at http://www.springer.com/series/8790

Naohiro Terasaka

Applications of Aminoacylation Ribozymes That Recognize the 3′-end of tRNA

Doctoral Thesis accepted by
the University of Tokyo, Tokyo, Japan

Springer

Author
Dr. Naohiro Terasaka
ETH Zurich
Zurich
Switzerland

Supervisor
Prof. Hiroaki Suga
The University of Tokyo
Tokyo
Japan

ISSN 2190-5053 ISSN 2190-5061 (electronic)
Springer Theses
ISBN 978-4-431-56515-4 ISBN 978-4-431-56517-8 (eBook)
DOI 10.1007/978-4-431-56517-8

Library of Congress Control Number: 2017932420

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer Japan KK
The registered company address is: Chiyoda First Bldg. East, 3-8-1 Nishi-Kanda, Chiyoda-ku, Tokyo 101-0065, Japan

Supervisor's Foreword

I am delighted to introduce Dr. Naohiro Terasaka, who received his Doctor of Science degree from the University of Tokyo in 2015. He is truly the most amazing student whom I have ever had in terms of his independence and ability in planning and conducting research.

In Dr. Terasaka's Springer Thesis, he has described his two major research programs that are quite different from each other. One of the programs involves engineering of a reconstituted translation system, where a new pair of ribosome–tRNAs acting orthogonally to the wild-type ribosome–tRNAs was invented. Using this new pair and wild-type pair, he has demonstrated the expression of two different peptides catalyzed by the respective ribosome–tRNA pairs from a single kind of mRNA. I believe that this work has made a strong impact on a growing area of chemical and synthetic biology, as published in *Nature Chemical Biology*, co-authored with Dr. Gosuke Hayashi and other members of my research group.

The other program involves a new technique developed in my research team, referred to as tRid (tRNA-Rid). The tRid was originally developed for facilitating isolation of small RNA fractions with lengths of 50–100 nucleotides, which are generally inaccessible in cellular RNA molecules because they overlap with mass numbers of tRNAs. Dr. Terasaka has applied this technique to the discovery of cellular RNA aptamers from small RNA transcripts isolated by the tRid. He was able to identify a human precursor microRNA, known as hsa-pre-miR-125a, capable of binding to folic acid. We referred to this technology as smaRt-SELEX (small RNA transcriptomic SELEX). This work was published in *RNA*, co-authored with Dr. Kazuki Futai and other members of my research group.

These works involve not only Dr. Terasaka's talent in conducting research but also his patient and steady efforts. I have no doubt that, without him these research programs could not have been realized and completed. Clearly, his achievements were recognized in various conferences, and he received several awards, such as the Best Presenter Award in the 15th annual meeting of the RNA Society of Japan (2013); the Sidney Altman Endowment Travel Award at the 25th tRNA conference (2014); and the Research Incentive Award from the Graduate School of Science,

the University of Tokyo (2015). He is currently working in ETH Zurich as a Human Frontier Science Program fellow under the supervision of Prof. Donald Hilvert and expanding his knowledge to protein science. I am delighted to see his further growth during his postdoctoral work.

On behalf of the Department of Chemistry, Graduate School of Science, the University of Tokyo, I would like to congratulate Dr. Terasaka on the Springer Theses Award. Personally, I sincerely wish him continued success in his career development with the hope that he will contribute to progress in science and technology in academics, industry, and society.

Tokyo, Japan
December 2016

Prof. Hiroaki Suga

Parts of this thesis have been published in the following journal articles

Terasaka N, Futai K, Katoh T, Suga H (2016) A human micro RNA precursor binding to folic acid discovered by small RNA transcriptomic SELEX. RNA. doi:10.1261/rna.057737.116

Terasaka N, Suga H (2014) Flexizymes-facilitated genetic code reprogramming leading to the discovery of drug-like peptides. Chem Lett 43 (1):11-19. doi:10.1246/Cl.130910

Terasaka N, Hayashi G, Katoh T, Suga H (2014) An orthogonal ribosome-tRNA pair via engineering of the peptidyl transferase center. Nat Chem Biol 10 (7): 555-557. doi:10.1038/nchembio.1549

Acknowledgements

I would like to express my sincere gratitude to Prof. Hiroaki Suga for his kind guidance, valuable suggestions, and encouragement throughout this work. I am deeply grateful to Prof. Naokazu Kano, Prof. Takayuki Katoh, Prof. Yuki Goto, and Prof. Toby Passioura for their helpful advice and discussion. I am greatly indebted to Dr. Kazuki Futai and Dr. Gosuke Hayashi for teaching me about experimental matters and discussing the research with me. I also thank all members of the laboratory.

I thank the Japan Society for the Promotion of Science (JSPS) for a grant and financial support.

Finally, I would like to thank my parents and brother for invaluable assistance and encouraging words.

Contents