Designing Yeast for Heavy Metal Waste Remediation

by

George L Sun

B.S., University of California, Berkeley (2014)

Submitted to the Department of Biological Engineering in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in Biological Engineering

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

May 2019

© Massachusetts Institute of Technology 2019. All rights reserved.
Author
Department of Biological Engineering May XX, 2019
Certified by
Professor of Biological Engineering and Material Science Thesis Supervisor
Accepted by
Forest M. White

Chair of Graduate Program, Department of Biological Engineering

Designing Yeast for Heavy Metal Waste Remediation

by

George L Sun

Submitted to the Department of Biological Engineering on May XX, 2019, in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Biological Engineering

Abstract

This is an abstract

Thesis Supervisor: Angela M. Belcher

Title: Professor of Biological Engineering and Material Science

Acknowledgments

This is the acknowledgements section.

This doctoral thesis has been examined by a Committee of the Department of Biological Engineering as follows:
Professor K. Dane Wittrup
Chairman, Thesis Committee
Professor of Biological and Chemical Engineering
Professor Angela M. Belcher
Professor of Biological Engineering and Material Science
Professor Cathy L. Drennan
Member, Thesis Committee Professor of Biology and Chemistry

Contents

In	trod	uction	3
1	Yea	st as a method for chemical precipitation	5
	1.1	Background	5
	1.2	Methods	5
	1.3	Results	5
2	Yea	st as a method for heavy metal absorption	7
	2.1	Background	7
	2.2	Methods	7
	2.3	Results	7
3	Yea	st as a method for sponge-like metal chelation	9
	3.1	Background	9
	3.2	Methods	9
	3.3	Results	9
4	Des	signing biological filters for heavy metal filtration	11
	4.1	Background	11
	4.2	Methods	11
	4.3	Results	11
5	De-	novo design of metal binding moieties using machine learning	13
	5.1	Background	13

	5.2	Methods	13			
	5.3	Results	13			
٨						
A	A Calculations 15					
	A.1	Cost	15			
	A.2	Uptake per cell	15			
	A.3	Density changes per cell	15			

List of Figures

List of Tables

Introduction

Waste treatment challenges

Physico-chemical methods

Bioremediation

Yeast as a method for chemical precipitation

- 1.1 Background
- 1.2 Methods
- 1.3 Results

Yeast as a method for heavy metal absorption

- 2.1 Background
- 2.2 Methods
- 2.3 Results

Yeast as a method for sponge-like metal chelation

- 3.1 Background
- 3.2 Methods
- 3.3 Results

Designing biological filters for heavy metal filtration

- 4.1 Background
- 4.2 Methods
- 4.3 Results

De-novo design of metal binding moieties using machine learning

- 5.1 Background
- 5.2 Methods
- 5.3 Results

Appendix A

Calculations

A.1 Cost

 \dots add table here \dots

A.2 Uptake per cell

A.3 Density changes per cell