Clearing the Air: Nitrogen Oxide Fixation for the Remediation of Coal Flue Gases

Missouri Miners
2014 Giant Jamboree
Burning fossil fuels releases flue gases
- Contain many pollutants
- Microbes can utilize
U.S. Power Sector Generation by Source – 2012

- Coal: 40%
- Natural Gas: 26%
- Nuclear: 20%
- Hydro: 7%
- Renewable: 6%
- Petroleum: 0%
- Other: 1%

Source: Energy Information Administration

http://www.nma.org/index.php/coal-statistics
Importance

- Impact of coal emissions per year in the U.S. (Schneider and Banks, 2010)
  - 13,000 premature deaths
  - 20,000 heart attacks
  - 1.6 million lost workdays
- Pollutants need to be filtered effectively and economically

Missouri S&T Coal Plant
Current Methods

- Lots of specialized equipment
- Each pollutant has a different method of removal
- Proper disposal of byproducts
Our Plan

- Create and identify preexisting BioBricks
- Express parts in photosynthetic organism
- Incorporate organism into bioreactor

NO\textsubscript{x}
In the Lab
Main Idea

Cyanobacteria

From E. Coli K12

hmp

norV

CO2

O2(g)

N2O

N2O(g)

Atmosphere

From P. aeruginosa PAO1

nrfA

nosZ

Fertilizer

NO

NO2~

NH3(g)

NO3~

Atmosphere
Gene Information

- **E. coli K12**
  - norV – oxidoreductase
  - Hmp – nitric oxide deoxygenase
  - nrfA – nitrite reductase

- **P. aeruginosa PAO1**
  - norCB – nitric oxide reductase
  - nosZ – nitrous oxide reductase
Results

So Far

- Bba_K113001 – nrfA
- Bba_K896005 – norCB
  - Bba_K896004 – nosZ and norCB together
- Bba_K1356006 – nosZ
- Bba_K1370000 – hmp

Still in Progress

- norV part
  - Internal PstI site removed
  - Ligation trouble
- nosZ part
  - Amplification troubles
  - Internal site needs removal
Future Directions

- Further characterize hmp
- Continue work on nosZ and norV
- Functionalize genes
- Test in bioreactor
Outreach
Campus Design Teams

- Student Design and Experiential Learning Center (SDELC)
- Prestigious group of student-led, competitive design teams
- We are the only biological engineering design team on our campus

What’s coming up:
- New lab space within the Center
- Building corporate partnerships
- Promoting the SDELC vision of student success
The Science Behind “The Immortal Life of Henrietta Lacks”

The Immortal Life of Henrietta Lacks

Doctors took her cells without asking. Those cells never died. They launched a medical revolution and a multimillion-dollar industry. More than twenty years later, her children found out. Their lives would never be the same.

Rebecca Skloot
Biological Sciences Open Lab

Celebration of Nations
Missouri S&T Homecoming Weekend

Other Events

- Exploring Synthetic Biology
- Play with DNA!
  - Residential Life: Midwest Regional Program of the Month Award
- Speak Up Speak Out
- Waynesville High School STEM Expo
- Engineers’ Week at St. Louis Science Center
- And many more!
References

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