

# Healthy Planet

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Three Ideas Presentation

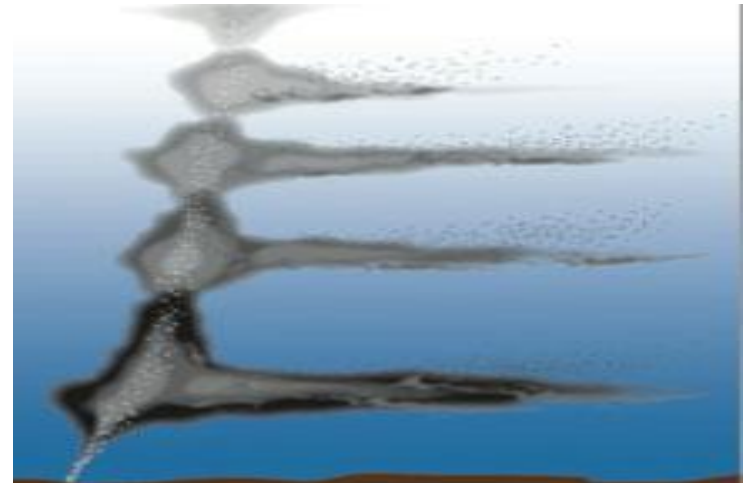
March 13, 2013

# Break it Down

*Engineering bacteria to undergo programmed cell death after breaking down hydrocarbons from oil spills.*

# Importance

- Oil spills cause extensive environmental damage
- Increase in offshore drilling
- Stratification causes multiple layers of damage



# Impact

- Break down to non-toxic compounds
- Acceleration of a natural process
- Less negative effects than current methods



# Competition

- Skimmers



- Burning



- Chemical Dispersants



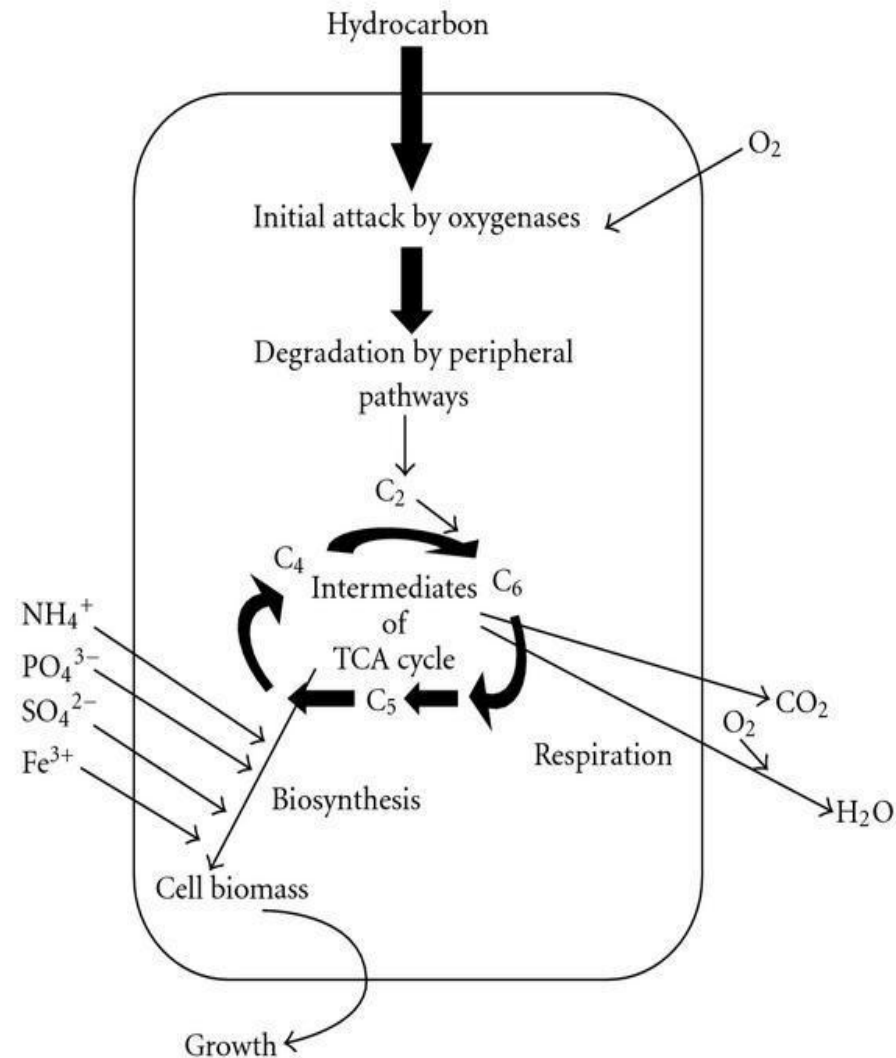
# Competition: Bioremediation

- Bacteria naturally break down hydrocarbons
- BUT
  - Current techniques require the addition of nutrients
  - No way to eliminate bacteria after spill is cleaned up



# Knowns

- Many microorganisms break down hydrocarbons
- Bacteria convert hydrocarbons into CO<sub>2</sub>
- Increased efficiency is possible
- Cell death can be triggered by color recognition



# Unknowns

- How often would bacteria have to be added?
- How much bacteria would we need?
- What process would we use to trigger cell death?





# Dust-Free

*Programmed plant genes that produce more leaf oil and resin to trap PM 2.5<sup>1</sup> from the air in urban area.*

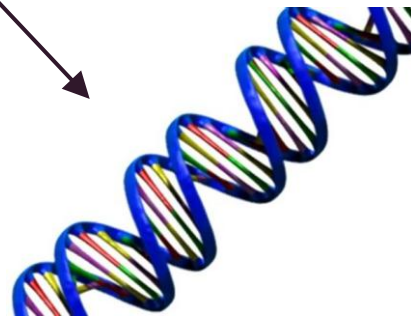
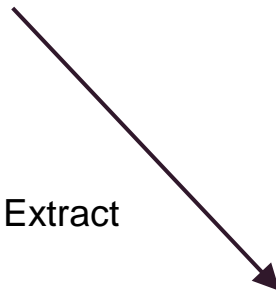
1. PM 2.5: particles that float in the air with diameter of 2.5 micrometers or less

# Big Picture



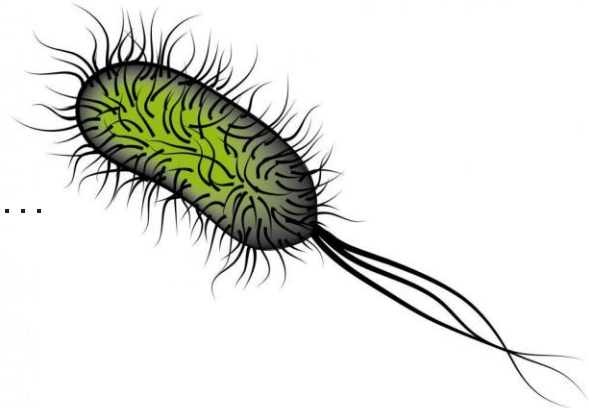
[www.rbwm.gov.uk](http://www.rbwm.gov.uk)

Extract



[www.prweb.com](http://www.prweb.com)

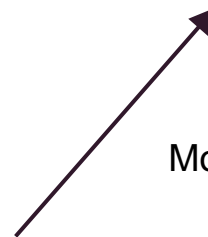
Modify and transfer



[www.wisegeek.com](http://www.wisegeek.com)

wiseGEEK

Modify and transfer



# Importance

- Desertification



<http://www.marketplace.org/topics/sustainability/what-would-your-city-look-beijings-air-smog-simulator>

- Respiratory Diseases



<http://en.paperblog.com/are-dust-mites-causing-your-child-s-allergies-155569/>

# Impact

- Reduce the incidence of respiratory diseases
- Relieve visual impairment
- Relieve Global Warming

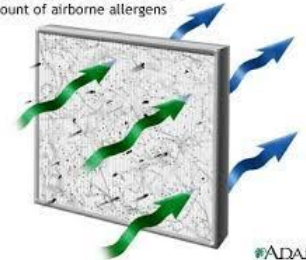


# Competition

- Natural solution
  - Low efficiency
  - Limited space in urban area
- Filters
  - Costly
  - Limitation to individuals
- Standard emission for engines
  - Emission still existing



A HEPA air filter can reduce the amount of airborne allergens



#ADAM



# Knowns

- The common constituents of resin: terpenes
- Pathway for resin production in conifers<sub>1</sub>
- Success in transformation of genes that can synthesize resins (monoterpene) into bacteria<sub>2</sub>
- Organs for producing leaf oil: pellucid glands<sub>3</sub>
- Pathway of oil accumulation and biosynthesis<sub>4</sub>

# Unknowns

- Efficiency of the cleaning
- Method of transferring modified genes back to plants
- Impact on ecosystem (insects, birds)
- Type of tree (evergreen)
- The amount that leaves can absorb before the pores fail to perform its function.

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CONSUMER SERVICE



# Poly-B-Gone

*Use naturally occurring compounds to break down plastics prevalent in landfills*



# Better Disposal of Plastics

- Recent increase in the drive to recycle plastics and produce new biodegradable plastics



- Long lasting plastics still clog up significant portions of landfills.

# The Problem

- Polystyrene, the third most widely-used plastic, degrades very slowly and accumulates in landfills.
- Landfill plastics take up large amounts of space and leech toxins into the ground and water over time.

## POLYSTYRENE:

- takes over 500 years to decompose
- takes up 30% of our landfills
- Polystyrene manufacturers are the 5th largest toxin producers in the world: this mean that polystyrene is very prone to leaking toxins

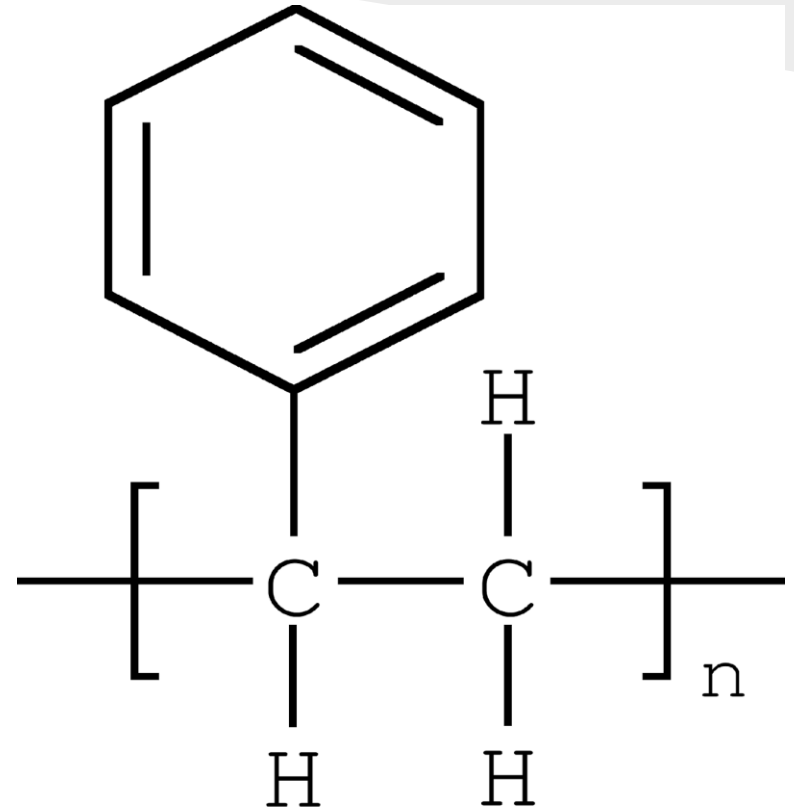
# Solutions and Impact

- The key goal is to create a bacteria able to easily synthesize a compound that can down PS.
- We would be able to significantly reduce the amount of PS in landfills, as well as facilitate its recycling.

# Competition

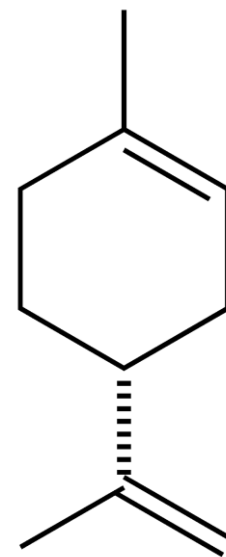
- Landfills are being treated with bacteria and fungi to break down other trash
- Biodegradable plastics
- Most plastics are high in energy and can be burned
- PS can be melted and reused: when PS is put in a vacuum, heated, and fed to a certain bacteria, the result is a new biodegradable plastic material

# Polystyrene (PS)

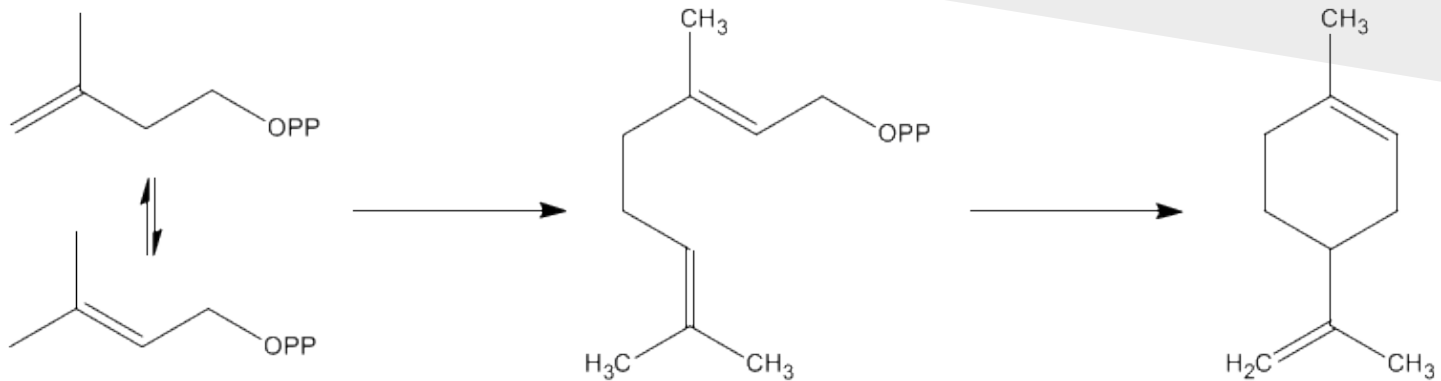


# Knowns

- PS is recyclable, but the nature of most PS products makes it inefficient to collect them for recycling.
- PS converts into an easily transportable and recyclable gel when exposed to D-limonene, a molecule found in citrus fruits.

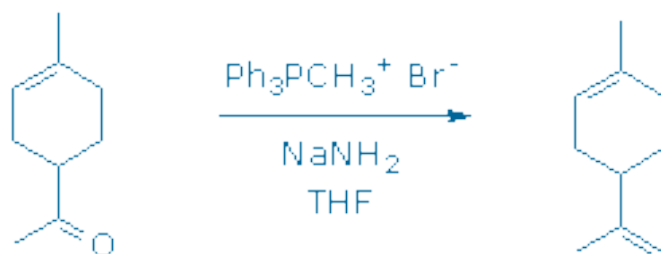
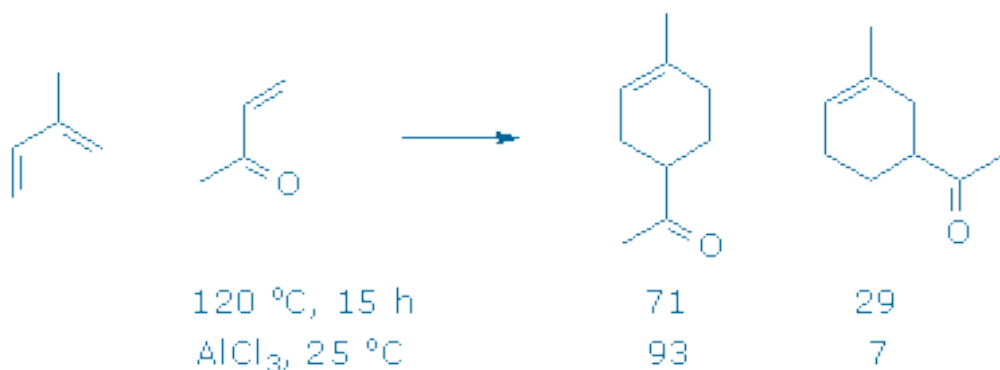


# Knowns



- Natural limonene synthesis pathway in citrus fruit
- The original compound (IPP) can be synthesized from Acetyl Co-A, a central molecule in the Krebs cycle
- Problem: 2012 iGem Wisconsin team tried this pathway to synthesize limonene in E.Coli and failed.

# Knowns



- Chemical synthesis of limonene
- Starting reactant, isoprene, can be produced by certain strains of bacteria (*Bacillus*)
- Problem: this requires high temperature



# Unknowns

- What are the possible side effects of limonene and the recycled gel plastic ?
- What other potentially negative effects could the bacteria producing the limonene have?
- What would the efficiency of the bacteria be? This is especially important as the 2012 iGem team produced a limonene yield of 0%.

# Break It Down References

<http://dx.doi.org/10.1016/j.techsoc.2010.10.010>

Nilanjana Das and Preethy Chandran, "Microbial Degradation of Petroleum Hydrocarbon Contaminants: An Overview," *Biotechnology Research International*, vol. 2011, Article ID 941810, 13 pages, 2011. doi:[10.4061/2011/941810](https://doi.org/10.4061/2011/941810)

[http://idosi.org/wasj/wasj17\(6\)12/19.pdf](http://idosi.org/wasj/wasj17(6)12/19.pdf)

<http://water.usgs.gov/wid/html/bioremed.html>

<http://events.embo.org/12-cell-death/>

<http://www.hindawi.com/journals/btri/2011/941810/tab5/>

[http://journals2.scholarsportal.info/details.xqy?uri=/1687157x/v10i0002/185\\_tioaaiobsuib.xml](http://journals2.scholarsportal.info/details.xqy?uri=/1687157x/v10i0002/185_tioaaiobsuib.xml)

<http://www.sciencedirect.com/science/article/pii/S0160791X10000771>

# Dust-Free References

1. Funk C, Croteau R. Diterpenoid resin acid biosynthesis in conifers: characterization of two cytochrome P450-dependent monooxygenases and an aldehyde dehydrogenase involved in abietic acid biosynthesis. Institute of Biological Chemistry, Washington State University Pullman 99164-6340.
2. Phillips, M. A. (2000). *Monoterpene biosynthesis in loblolly pine (pinus taeda)*. Washington State University). *ProQuest Dissertations and Theses*, , 135.
3. Ricardo V, Piero D, Gilda. Anatomical and chemical analyses of leaf secretory cavities of *Rustia formosa* (Rubiaceae) *Am. J. Bot.* December 2001 vol. 88 no. 12 2151-2156
4. Slocombe SP, Cornah J, Pinfield-Wells H Oil accumulation in leaves directed by modification of fatty acid breakdown and lipid synthesis pathways. *Plant Biotechnol J.* 2009 Sep;7(7):694-703. doi: 10.1111/j.1467-7652.2009.00435.x.

# Poly-B-Gone References

<http://www.usc.edu/CSSF/Current/Projects/S0626.pdf>

<http://en.wikipedia.org/wiki/Limonene>

[http://www.enzyscreen.com/AMB\\_2003\\_Duetz\\_et\\_al.pdf](http://www.enzyscreen.com/AMB_2003_Duetz_et_al.pdf)

<http://2012.igem.org/Team:Wisconsin-Madison/lemon>

<http://woohooreport.com/2009/09/wci-student-isolates-microbe-that-lunches-on-plastic-bags/>

[http://www.ucd.ie/cscb/main\\_pages/news/news010306.htm](http://www.ucd.ie/cscb/main_pages/news/news010306.htm)

<http://www.plantphysiol.org/content/117/3/901.full>

<http://openwetware.org/wiki/IGEM:MIT/2006/Blurb>

<http://www.chm.bris.ac.uk/motm/limonene/limoneneh.htm>

[http://academic.reed.edu/chemistry/alan/201\\_202/lab\\_manual/expt\\_limonene/background.html](http://academic.reed.edu/chemistry/alan/201_202/lab_manual/expt_limonene/background.html)

<http://link.springer.com/article/10.1007%2F978-1-4020-2941-90?LI=true>

# Acknowledgement

Thank you Ryan and Kristine!

Any questions?

