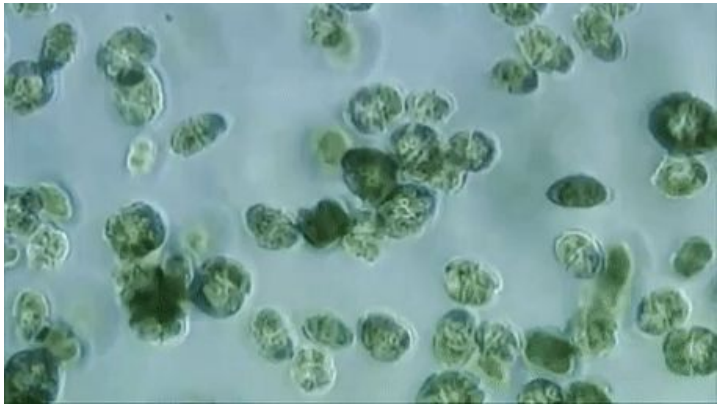
Aquatic Ecosystems

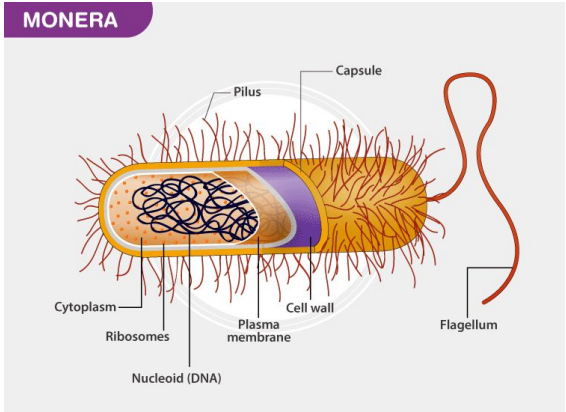
A Collaborative Effort between the Baltimore BioCrew and CLS CLSG UK

Aquatic Ecosystems

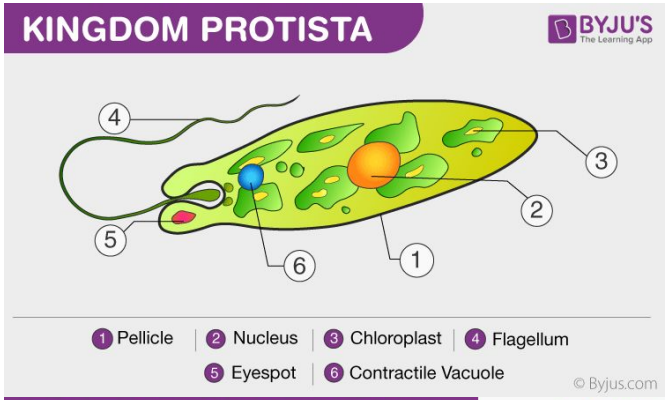


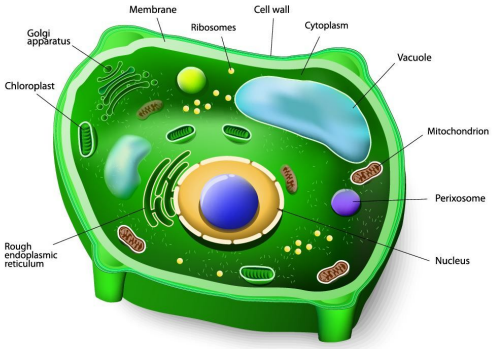
Taxonomy

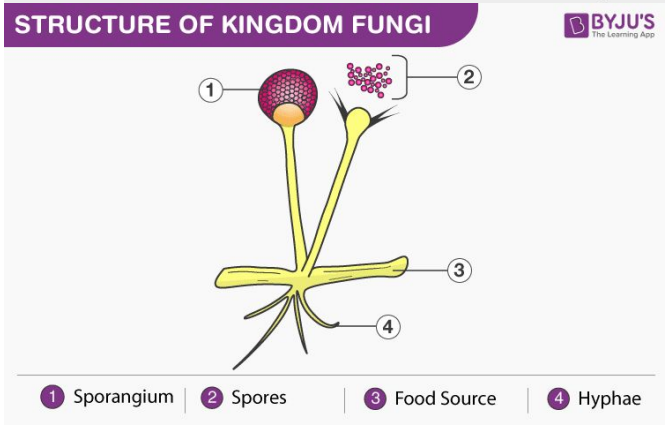
Prokaryotes

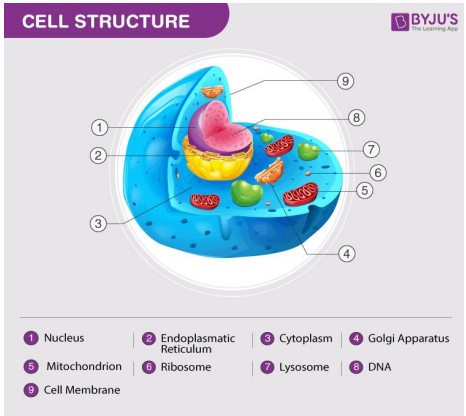


Eukaryotes







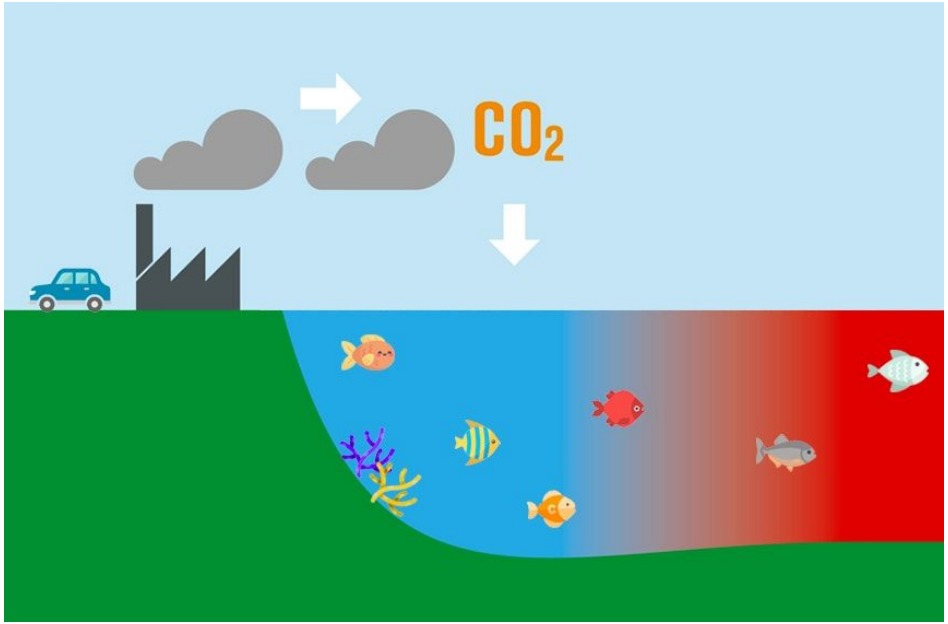


Climate Change in the Ocean

Greenhouse Gas Emissions

- **Greenhouse Gas:** Gases that trap heat in the atmosphere by reflecting IR radiation back to the surface
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
- **Greenhouse Effect:** The natural warming of the earth due to the reflection of IR radiation by greenhouse gases
- CO_2 is the most prevalent greenhouse gas
  - Decomposition
  - Respiration
  - Burning of Fossil Fuels
  - Deforestation

Ocean Acidification



Bleaching of fire coral in Bermuda (XL Catlin Seaview Survey)

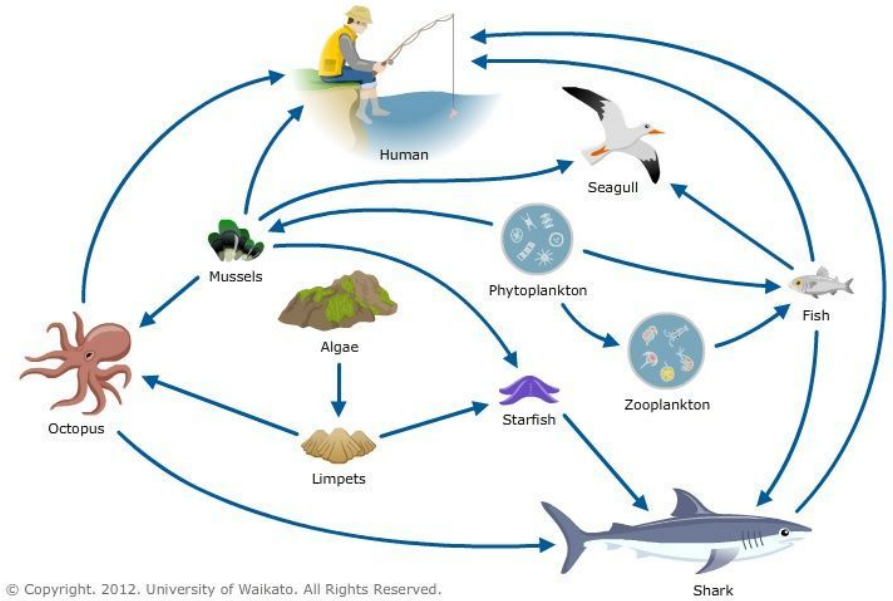
Impact on Phytoplankton

Phytoplankton

- Phytoplankton are microscopic organisms that live in **fresh- or salt** water environments
- Some phytoplankton are bacteria or protists. Most are single-celled plants.

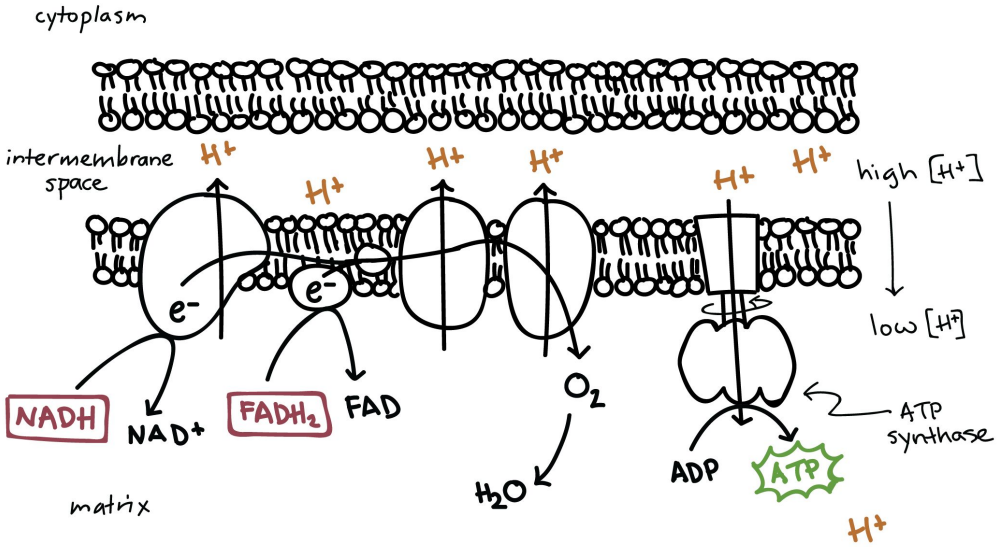
Ocean Food web

- **Food Web:** Way of conceptualizing predator-prey interactions
- Phytoplankton are at bottom of food web
- Effects in this population reverberate to apex predators
- Phytoplankton decrease means instability for all organisms in the food web
- Climate change has a direct effect on this



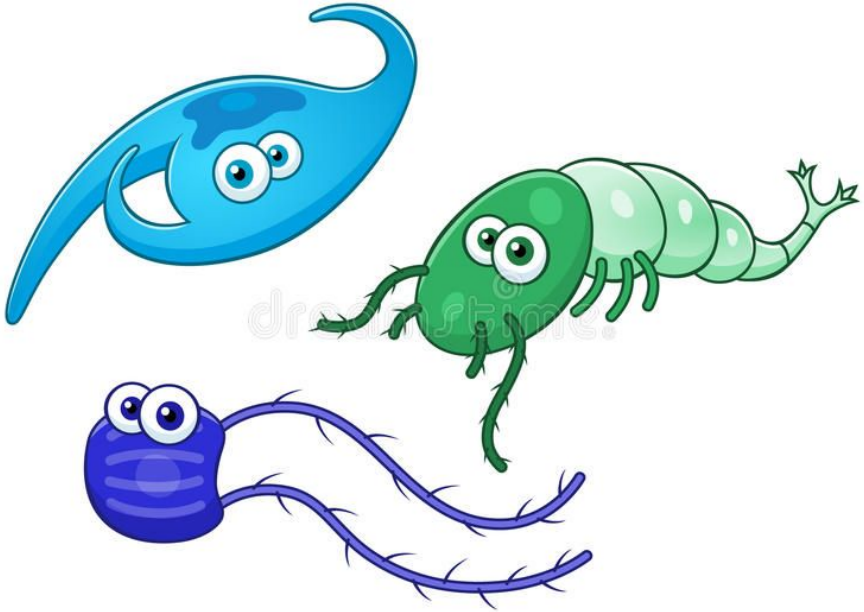
Iron as a Fertilizer

- Iron = Energy
- Iron concentration is decreasing in the ocean by 1% annually
- Trials have been conducted dumping iron into the ocean to boost this vital nutrient.



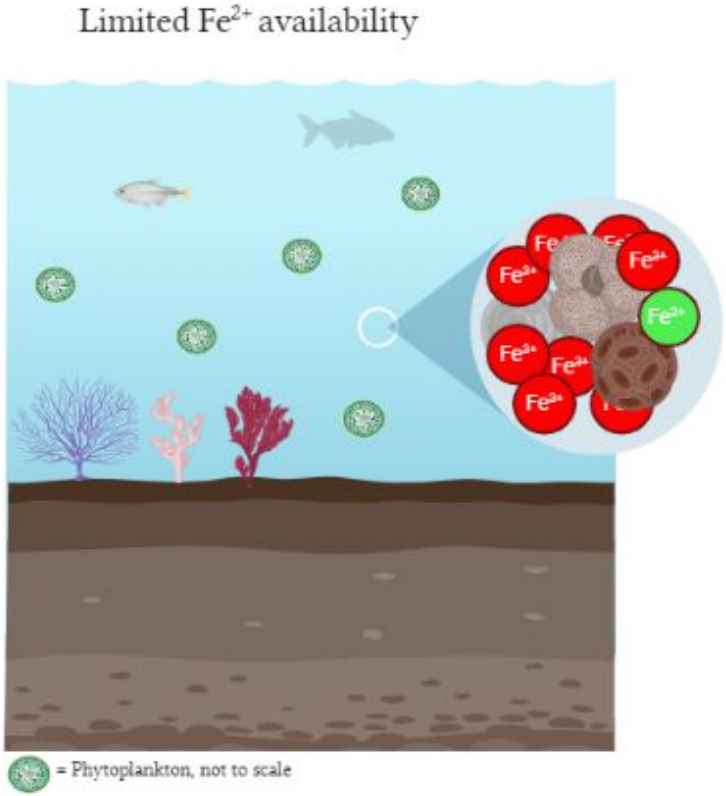
Why Iron?

- Using Iron as a fertilizer increases phytoplankton population
- Greater phytoplankton population = greater photosynthetic activity
- Greater photosynthetic activity would strip more CO_2 from the atmosphere, combating the problem of global warming.



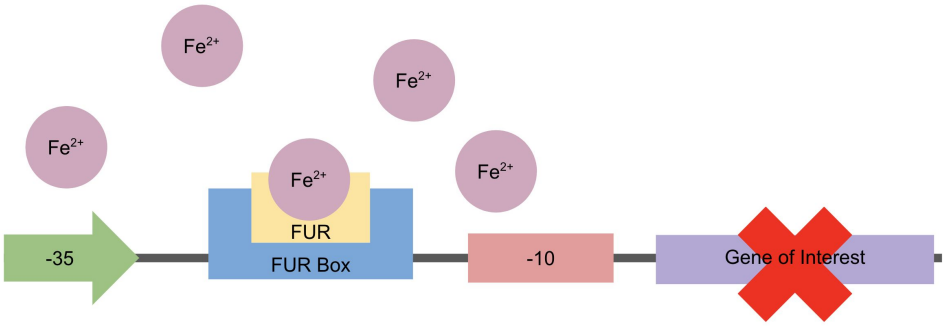
Our Solution

Improving Iron Consumption Efficiency in Cyanobacteria



- Our project will modify cyanobacteria with genes related to iron consumption
- We reason that bringing together the genes into one strain it will enhance the ability of phytoplankton to grow in varying ocean conditions that are low in iron.
- Hopefully it will lead to an increase in photosynthesis of phytoplankton.

Controlling the Growth of our Cyanobacteria



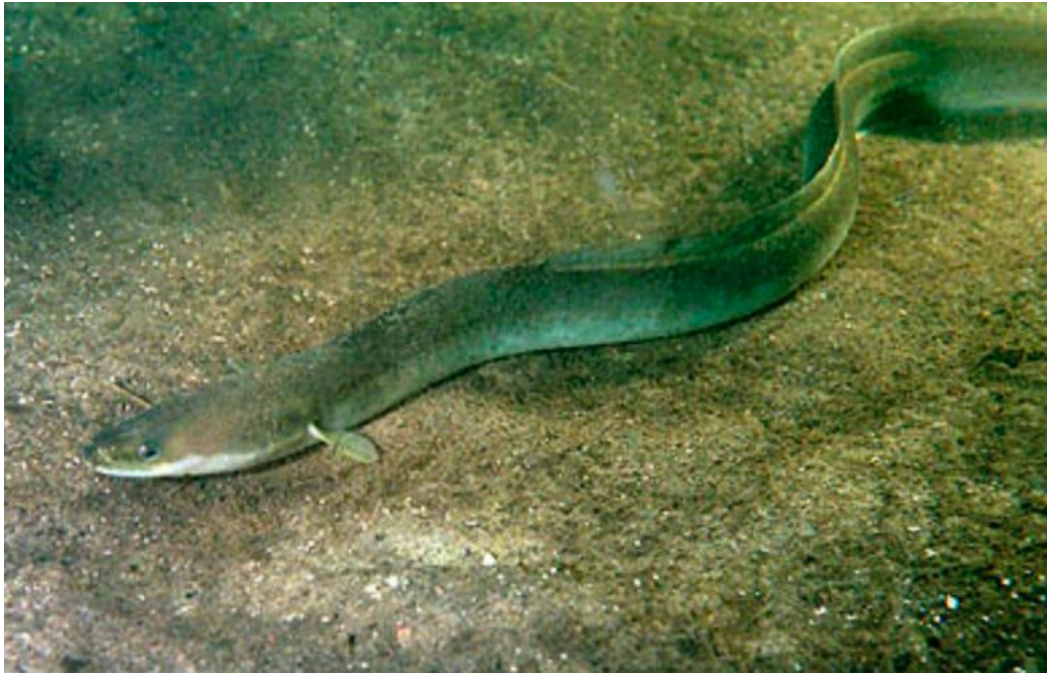
- We designed a kill switch, a gene that is like a self destruct function for living things.
- This kill switch is iron sensitive, so that if the iron concentration gets too high, the phytoplankton will begin to die.

Cocaine in the River Thames

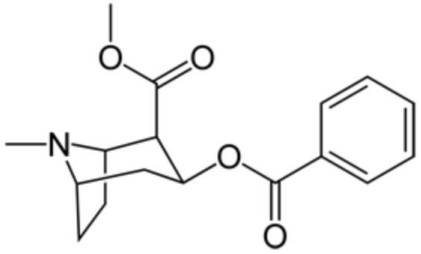
Our school is located right on the bank of the River Thames - we thought it would be important to do a project on species conservation

The European Eel

1. Numbers have declined by 90% since the 1970s
2. They are critically endangered [1] due to a decrease in their reproduction rates
3. River pollution is a factor involved with these decreasing rates



Cocaine



- Cocaine molecules are not fully metabolised in the body and once in the London sewage system, cocaine molecules aren't fully removed
- 30ng of cocaine remains in the effluent flow and causing severe damage once in the River Thames
- The cocaine causes severe damage to the eels' skeletal muscles which may result in rhabdomyolysis
- This damage changes the eels' breeding path resulting in a decreased reproduction rate

Our Solution

Circuit design

- We will use a genetically modified E. coli containing a constitutive circuit for Cocaine Esterase
  - Cocaine Esterase is the key enzyme in breakdown of Cocaine molecules
- We plan to use a hypoxia kill switch which would prevent our bacteria from infiltrating external ecosystems

Sewerage Location

- We plan to place our circuit on the lamella clarifiers in the sewerage system as this is where the flow rate is lowest
- This means high contact time between our circuit and the sewage
- Our circuit then can breakdown the cocaine molecules in the sewage preventing them from being released into the river

What can YOU do to help?

- Don’t pollute rivers
  - Throw away rubbish in marked bins not the water
  - Do not dump chemical waste into the rivers
- Keep aware of the endangered species in your area
  - This project was important for us and if you feel something is personal to you you’ll be more likely to make a change
- Teach about the issues
  - Make sure your friends don’t pollute
- Donate to charities which support endangered species and work to prevent their extinction
- Keep track of projects such as iGEM projects which aim to tackle world issues creatively

What You Can Do

- Don’t throw trash in the sewage management systems
- Support fundraisers
- Post on social media
- Start conversations with friends and family
- Educate yourself
- Be mindful of your carbon footprint

We think it's really important to teach about synthetic biology so we've made a video to teach about iGEM in school and hope to hold a Q&A session with the younger children

We also spoke to several companies who work to help endangered species and spoke to Thames Water to understand the sewerage system and where we can implement our project

Acknowledgements

Baltimore BioCrew 2020:

Adam Hoffensetz
Alex Misiaszek
Angelique Allen
Avipsa Hamal
Harry Wojcik
Heaven Cross
Joshua Dayie
Kayla Le
Maria Lyons
Max Swann
Nathan Dayie
Sam Ferraro
Shantika S Bhat
Shubhan S Bhat
Zoe Hsieh
Andy Johnston
Breanna Takacs
Guoyue Xu
Kalen Clifton
Lisa Scheifele
Nina Rajpurohit
Wangui Mbuguiro

CLS_CLSG_UK_iGEM:

Alexander Wallop
Alexandre Roger
Ameen Hassan
Antonios Tsaknakis
Arabella Henderson
Asad Khan
Beatrix Villiers
Cassidy Ashworth
Ela Tabbouche
Ethan Ying-Jun Santos
Gabriel Ashdown
Gautam Krishna
Isaac Tolley
Isabella Yeo Frank
Jared Stoloff
Jian Hui Mo
John Robin Carlyon
Joseph Hee
Kaavya Kanagarajah
Konstantinos Attilakos
Louis Gringras
Lucas Czajka
Lucza Losonci Johnson
Milla Ivanova
Miya Heap
Nassim Younes
Nathan Leung
Peter Heywood
Ravi Joshi
Rohan Prakash
Ron Kurtzbard
Sahil Shah
Saul Cooperman
Taybah Crorie
Yashaar Daad
Yeshin Yoon
Zayd Ahmed

References

https://earthobservatory.nasa.gov/features/Phytoplankton

https://www.postandcourier.com/news/ocean-waters-off-southeast-coast-are-acidifying-faster-than-anyone-expected-and-threatening-marine-life/article_b7ca31d8-fdd3-11e6-ba03-9f55adfbac57.html#:~:text=Buy%20Now

https://www.iucnredlist.org/species/60344/12353683