PIPECLEANER PLASMIDS
STUDENT GUIDE

Purpose

This activity provides students with an introduction to the field of synthetic biology and provides examples of how this process could be applied to enhance the process of bioremediation

SCENARIO 1

Example

BioDesign Inc. is a world-leader in the applications of bioengineering to a wide range of problems. As a bioengineer at the firm, you are tasked with designing custom bacteria that are able to deal with these problems. As a practice task, work with the group leader to design a Pipecleaner Plasmid which is suitable for life off the coast of British Columbia. The bacteria must be able to survive in the following conditions

- Life in a temperature range of 10 – 24
- Able to digest hydrocarbons and metabolize oxygen
- Be able to reproduce

Following your practice exercise, it is time to tackle a real task. There has been an environmental disaster! As the lead bioengineering team at BioDesign you have been asked to design a strategy to deal with the disaster using a process of bioremediation.

1. The Great Pacific Garbage Patch
http://www.youtube.com/watch?v=2VrrxMIiwgQ

This ocean landfill is a gyre of marine litter in the central North Pacific Ocean. It was formed gradually as a result of marine pollution gathered by oceanic currents. Unlike debris, which biodegrades, the photodegraded plastic disintegrates into ever smaller pieces while remaining a polymer. Let's imagine that the plastic composition of the garbage is 50% plastic bottles (which photodegrades into polymer A), 35% plastic bags (polymer B) and 15% can be attributed to plastic action figures (polymer C). Some of these plastics decompose within a year of entering the water, leaching potentially toxic chemicals so time-sensitive cleanup is important. The conditions are cold (2 to 12°C) saltwater, with plastic particles spanning over a large area with a variable composition.

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GENE LEGEND

NAME	FUNCTION	SIZE	COLOR	Example	Scenario
METABOLISM					
MPA_8	Plastic container (polymer A) metabolism	6	PURPLE		
MPB_4	Plastic bag (polymer B) metabolism	3	PURPLE		
MPC_3	Plastic toy (polymer C) metabolism	2	PURPLE		
MPF_1_6	Pure Fuel - Crude Unrefined Oil Metabolism	5	BLACK		
MHM_1_8	Heavy metals (Lead)	6	BEIGE		
MHT_2_7	Suitable for life in temperature range from 22 to 30°C	6	BROWN		
MMT_2_3	Suitable for life in temperature range from 10 to 24°C	3	BROWN		
MLT_2_5	Suitable for life in temperature range from 2 to 12°C	5	BROWN		
MHDE_3_4	Hydrocarbon Digestion – Necessary for **ALL Fuel metabolism**	6	ORANGE		
MHDE_3_4	Polycarbon Digestion – Necessary for **ALL Polymer metabolism**	3	ORANGE		
MOME_6	Oxygen Metabolism – Necessary for **ALL organisms**	3	WHITE		
REPRODUCTION					
RHRR_7	High Reproduction Rate – Grows quickly	7	OLIVE		
RMRR_5	Medium Reproduction Rate – Grows moderately	5	OLIVE		
RMSC_5	Medium Colony Size	5	LTBLUE		
RSCS_4	Small Colony Size	4	LTBLUE		
SURVIVAL					
SDRE_7	Salinity survival	5	GRAY		
SAAPS_4	Acidic pH Survival	4	PINK		
SBPS_4	Basic pH Survival	6	PINK		
OTHER					
OSGHT_6M_3	Suicide Gene – High Telomerase – Survive 6 months	3	DKBLUE		
OSG-ISG	Suicide Gene – Inducible Suicide BioDesignOrganismide	5	DKBLUE		
OSFTR	Fluorescent Tracking – Advantage easy & cheap	1	MAROON		

*Every gene requires a Promoter (Green), Ribosome binding site (Yellow) and Terminator (Red) bead.

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2. Gulf of Mexico Oil Spill

A drilling rig has collapsed off the coast of Florida in the Gulf of Mexico. It is estimates that it will spill up to 1 billion barrels of crude oil before the leak is sealed. The large size of this disaster will require a large remediation effort in order to restore the water to a clean state. Of note for bioengineering strategies, the climate in the water requires bacteria, which can thrive in warm waters ($20^{o}C$ – $28^{o}C$) as well as process crude unrefined oil as a substrate. The spill is quite close to shore, so it is necessary to rapidly clear the product (within 6 months) before it contaminates coastal ecosystems.

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3. Landfill

A landfill is a method of solid waste disposal by burying it under layers of earth. In Canada, we have a recycling system accessible to 96% of Canadians; however, there are some plastics which end up in the landfill since they are considered a contaminant in residential recycling programs. We propose using synthetic biology to help degrade the unrecyclable plastic products. The composition of the disposed plastic is: 25% low density polyethylene frozen food bags (polymer B), 50% containers (polymer A and B), which previously contained crude motor oil and still has oil residues, and 25% Polystyrene toys (polymer C). The landfill is large and is of a mid temperature range: $13^{o}C$ – $22^{o}C$.

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