**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

**SCENARIOS**

**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**](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.

1. **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 (20oC – 28oC) 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.

1. **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: 13oC – 22oC.

**PIPECLEANER PLASMIDS**

**GENE LEGEND**

**MAXIMUM SIZE OF PLASMID IS 45 kb**

|  |  |  |  |
| --- | --- | --- | --- |
| **NAME** | **FUNCTION** | **SIZE** | **COLOR** |
| **METABOLISM** |
| MPA\_8 | Plastic container (polymer A) metabolism | 6 | FUSCHIA |
| MPB\_4 | Plastic bag (polymer B) metabolism  | 3 | FUSCHIA |
| MPC\_3 | Plastic toy (polymer C) metabolism | 2 | FUSCHIA |
| 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 | PINK |
| MHDE\_3\_4 | Polycarbon Digestion – Necessary for **ALL Polymer metabolism** | 3 | PINK |
| MOME\_6 | Oxygen Metabolism – Necessary for **ALL** **organisms** | 3 | WHITE |
| **REPRODUCTION** |
| RHRR\_7 | High Reproduction Rate – Grows quickly | 7 | LIGHT BLUE |
| RMRR\_5 | Medium Reproduction Rate – Grows moderately | 5 | LIGHT BLUE |
| RMSC\_5 | Medium Colony Size  | 5 | YELLOW |
| RSCS\_4 | Small Colony Size  | 4 | YELLOW |
| **SURVIVAL** |
| SDRE\_7 | Salinity survival | 5 | SILVER |
| SAAPS\_4 | Acidic pH Survival | 4 | RED |
| SBPS\_4 | Basic pH Survival | 6 | RED |
| **OTHER** |
| OSGHT\_6M\_3 | Suicide Gene – High Telomerase – Survive 6 months | 3 | BLUE |
| OSG-ISG | Suicide Gene – Inducible Suicide BioDesignOrganismide | 5 | BLUE |
| OSFTR | Fluorescent Tracking – Advantage easy & cheap | 1 | GOLD |
|  |  | 93 |  |