**PIPECLEANER PLASMIDS**

**INSTRUCTOR GUIDE**

**Purpose**

This activity will expose students to the real life applications of synthetic biology and catalyze creative thinking for future, potential iGEM projects.

**Materials for each group (groups of 3 to 5)**

* Pipe cleaner set (12 colours)
* Ruler
* Scenario & Worksheet
* Gene Legend
* Calculator (optional)

**Instructions**

Provide some background information:

* How is the DNA of E. coli different?
* What are plasmids and how can they be created?
* What is synthetic biology?
* What are some of the controversies of using synthetic biology?

To start, have group choose a scenario and let them create their ideal plasmid with no size limit. The students must find the important information from the scenarios to choose the appropriate genes for their plasmids.

Then, impose size restrictions on the plasmids based on instability of larger size plasmids. The new size to aim for is around 25kb. The students will then have to choose what genes are the most beneficial to their given scenario and which ones can be eliminated or changed.

Swap plasmids with another group and try to guess which scenario the plasmid belongs to. Allow the groups to give feedback and suggestions to each other.

Finally, have the groups present their plasmid along with justification for why they chose the certain genes.

**Optional:**

* Introduce new factors to the scenario as the students are creating their plasmids.

Example: “There have also been traces of lead/base/acid found in \_\_\_\_\_\_\_\_”

* Have the students create their own scenario using the gene legend as a resource, or allow them to add new genes to the legend. Be creative! It could be imaginary!

**PIPECLEANER PLASMIDS**

**SCENARIOS**

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.

|  |  |  |  |
| --- | --- | --- | --- |
| **GARBAGE PATCH** |  |  |  |
| **NAME** | **FUNCTION** | **SIZE** | **COLOR** |
| 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 |
| MLT\_2\_5 | Suitable for life in temperature range from 2 to 12C | 5 | BROWN |
| 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 |
| RMSC\_5 | Medium Colony Size  | 5 | YELLOW |
| **SURVIVAL** |
| SDRE\_7 | Salinity survival | 5 | SILVER |
| OSG-ISG | Suicide Gene – Inducible Suicide BioDesignOrganismide | 5 | BLUE |
| OSFTR | Fluorescent Tracking – Advantage easy & cheap | 1 | GOLD |
|  | **SUM** | **45** |  |

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.

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| **GULF OIL SPILL** |  |  |  |
| **METABOLISM** |
| MPF\_1\_6 | Pure Fuel - Crude Unrefined Oil Metabolism | 5 | BLACK |
| MHT\_2\_7 | Suitable for life in temperature range from 22 to 30C | 6 | BROWN |
| MHDE\_3\_4 | Hydrocarbon Digestion – Necessary for **ALL Fuel metabolism** | 6 | PINK |
| MOME\_6 | Oxygen Metabolism – Necessary for **ALL** **organisms** | 3 | WHITE |
| **REPRODUCTION** |
| RHRR\_7 | High Reproduction Rate – Grows quickly | 7 | LIGHT BLUE |
| RMSC\_5 | Medium Colony Size  | 5 | YELLOW |
| **SURVIVAL** |
| SDRE\_7 | Salinity survival | 5 | SILVER |
| **OTHER** |
| OSGHT\_6M\_3 | Suicide Gene – High Telomerase – Survive 6 months | 3 | BLUE |
| OSFTR | Fluorescent Tracking – Advantage easy & cheap | 1 | GOLD |
|  | **SUM** | **41** |  |

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.

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| --- | --- | --- | --- |
| **LANDFILL** |  |  |  |
| **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 |
| MMT\_2\_3 | Suitable for life in temperature range from 10 to 24C | 3 | 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 |
| RMSC\_5 | Medium Colony Size  | 5 | YELLOW |
| **SURVIVAL** |
| **OTHER** |
| OSG-ISG | Suicide Gene – Inducible Suicide BioDesignOrganismide | 5 | BLUE |
| OSFTR | Fluorescent Tracking – Advantage easy & cheap | 1 | GOLD |
|  | **SUM** | **49** |  |

**PIPECLEANER PLASMIDS**

**GENE LEGEND**

|  |  |  |  |
| --- | --- | --- | --- |
| **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  | 5 | BLUE |
| OSFTR | Fluorescent Tracking – Advantage easy & cheap | 1 | GOLD |
|  | SUM | 93 |  |