It has always been the objective of iGEM Paris Bettencourt to conduct novel projects. This year, our team has decided to explore a topic that has rarely been approached by synthetic biologists in this competition: odor.

Human olfaction relies on a tremendous number of cellular receptors that can detect specific molecules in the air. Upon the detection of combination of these compounds, a message is sent to the brain, which leads to the perception of one unique odor. There is considerable work left to do in order to understand the sense of smell, especially in determining how olfactory receptors operate.

Few synthetic biologists have tried to engineer bacteria to produce smell or to treat bad smell since the production of odor by microorganisms is not studied often. One reason for the lack of study in this area is that it is hard to quantify and characterize an odor. We will overcome this by using odor professionals and commonly used scientific tools. We want to do this in order to investigate the links between our skin microbiota and body odor, as well as the perception of one's body odor by others.

We are currently working on several projects:

- Engineering bacteria to produce an odor library
- Designing probiotics and cosmetic products aimed to help people with strong body odour
- Treating a genetic disease leading certain persons to have strong malodour
- Launching a citizen science project aiming to learn about our microbiomes and how people perceive other's smell

Escherichia coli, a bacterium commonly used in lab, naturally produces the odor of stool. The pleasant odor library aims to not only eliminate the unpleasant smell in *E. coli*, but also to produce appreciable ones, like those of jasmine, banana, and lemon.

We hope to establish a database of gene sequences that produce the compounds corresponding to various odors that can be assembled with a standard promoter in *E. coli*. We are using a study that statistically concluded the ten primary categories of odor that human beings perceive through an analysis of words used to describe smell in order to decide the smells we will produce. By covering all or most of the ten categories, we will be able to produce a large variety of odors.

It has been found that most body odors are caused by one particular bacterium found in the skin microbiome: *Corynebacterium striatum*. *C. striatum* metabolizes sweat compounds into volatile sulfurous compounds that smell. However, due to the high rate of bacterial cell division, there is a high likelihood for mutants of *C. striatum* to appear. The goal is to isolate a mutant of *C. striatum* that contains a mutation in the gene, *agaA*, which is primarily responsible for body odor. This natural mutant would have a non-functional *agaA* gene; therefore, it would not produce any smell.

We plan to achieve this goal by using a technique known as CRISPR. CRISPR allows us to selectively kill a bacterium by targeting a very specific part of its genome. Thus, we will kill all normal *C. striatum* by targeting their genome, allowing us to find the natural mutants that survive the CRISPR. Thus, we will be able to produce a novel probiotic cosmetic using natural bacteria and treating body malodor.

Another part of our project aims to neutralize natural unpleasant body odor in seniors. It has been found that with age, there is an increase in the amount of 2-nonenal on the surface of skin. This compound has a very specific strong odor perceived as iris, fat, and cucumber. This substance may be a reason of discomfort and social problems for people over the age of 40.

In this subproject, we want to evolve bacteria that are a natural part of the skin microbiome, namely *C. striatum*, to scavenge for the 2-nonenal. We will sequence the bacterial genome before, and after the directed evolution process, in order to see the mutations that occur. We will also observe the fitness of the 2-nonenal consuming bacteria in comparison to the wild-type ones, especially in seeing how they survive in a culture of other wild-type skin bacteria.

Another subproject that we are working on has to do with a rare genetic disease caused by the lack of production of the enzyme Flavin-containing monooxygenase 3 due to a mutation in the gene with the same name known as trimethylaminuria, or fish-odor syndrome. This disease results in the excretion of an unpleasant smelling compound known as trimethylamine.

We found that the bacteria *Ruegeria pomeroyi* produces an enzyme called Trimethylamine monooxygenase, which has the ability to convert trimethylamine into trimethylamine-oxide, a compound that is odor-less. Our goal is to clone this gene into *C. striatum*, since that is naturally present on our skin, and develop a cosmetic cream containing this product. Using this cream would allow people suffering from fish-odor syndrome to suppress the symptoms related to it.

Finally, we want to improve the knowledge of human microbial flora. We have decided to conduct an open citizen science project called “Gym Class Heroes.” The objective of this project is to create a massive and open database of the sequences in the microbiome of the human axilla. To do this, we will collect samples from volunteers, sequence their sweat microbiome and correlate it to their body odor. The long-term objective of this project is to identify wild type variants of odorous bacteria that have lost their bad odor due to a natural mutation and to use these natural variants to create probiotic cosmetics.

As a citizen science project, we will give people the opportunity to help us analyze our data and learn more about their own microbiome. We will also offer them the possibility to discover how others perceive their natural odor.