Living Deodorant - *A Synthetic Biology Experiment for Redirecting Sulfur-Based Body Odor into a Wintergreen Scent*

Ayal Bark

PROBLEM / MOTIVATION

Body odor doesn't come from sweat on its own. It happens when bacteria living on our skin break down certain chemicals in sweat and turn them into smelly sulfur-based compounds such as thioalcohols. In the underarm area, this process produces strong odors that we experience as body odor.

Most deodorants work after the smell has already formed, either by covering it up or by killing bacteria across the board. This project explores a different idea: using a genetically engineered organism that can detect odor-related sulfur chemistry and respond only when it's needed, instead of working constantly or indiscriminately.

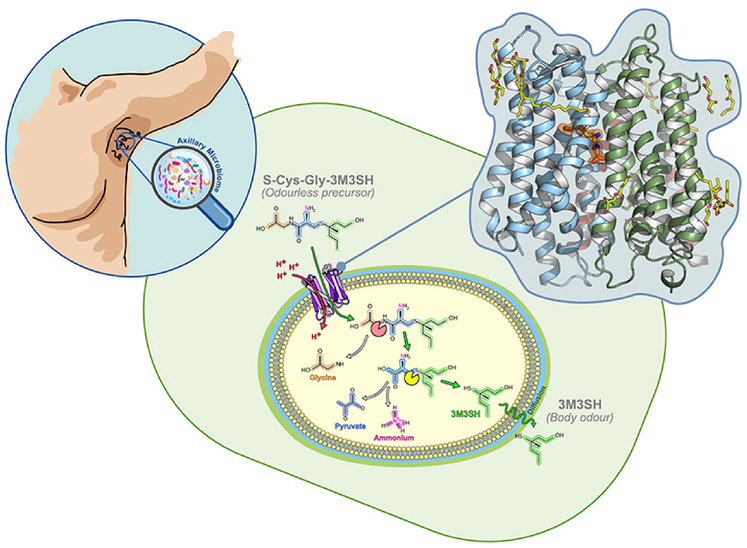

Figure 1: Picture showing how body odor is produced in armpits. Credits: University of York and Oxford.

HYPOTHESIS

If bacteria carrying a sulfur-responsive genetic circuit that includes the SAMT gene are exposed to sulfur-related odor chemicals in the presence of salicylic acid, then activation of the Psqr promoter will drive methyl salicylate production, producing a detectable wintergreen odor.

LIMITATIONS

This project uses sulfur-related odor chemicals as a simplified signal, even though real body odor is caused by more complex molecules produced inside skin bacteria. The system is designed to respond to sulfur as a proxy, which helps demonstrate the sensing and response logic but does not fully replicate how body odor forms naturally.

Methyl salicylate production also depends on the availability of salicylic acid, which is assumed to be supplied as part of the deodorant formulation rather than produced by the bacteria themselves.

In addition, the bacterial strain used here is intended only as a laboratory model to test the genetic circuit. It is not designed for use on human skin, and real-world application would require a different organism and additional safety considerations. Finally, changes in odor are assessed at a conceptual level, and detecting or measuring scent would require further chemical validation.

GENETIC PARTS INVENTORY

The genetic circuit is assembled from well-characterized biological components commonly used in synthetic biology:

- **SqrR:** A sulfur-responsive transcriptional regulator that represses gene expression in the absence of sulfur-related reactive species.
- **Psqr:** The promoter regulated by SqrR. When sulfur-related chemistry is present, repression is lifted and Psqr activates downstream gene expression.
- **SAMT (Salicylic Acid Methyltransferase):** An enzyme that converts salicylic acid into methyl salicylate, a volatile compound with a characteristic wintergreen scent.
- **GFP (Green Fluorescent Protein):** A fluorescent reporter protein used to visually indicate when the promoter Psqr is active.
- **Hydrogen sulfide (H_2S):** Used as a proxy input to approximate sulfur-related odor chemistry.

SYSTEM DESIGN: THE GMO

A standard laboratory strain of *Escherichia coli* is used to test how the genetic circuit behaves in a controlled environment.

The system is made up of three connected parts that work together: a sensing module, an output module, and a reporter module.

Sensing Module The circuit uses a sulfur-sensitive regulatory protein called SqrR to control a promoter called Psqr. When sulfur-related chemicals are not present, SqrR keeps the promoter turned off. When sulfur-related chemistry is present, this repression is lifted and Psqr turns on gene expression. In this project, sulfur sensing is approximated using hydrogen sulfide as a proxy signal.

Output Module Once Psqr is activated, it drives expression of the enzyme salicylic acid methyltransferase (SAMT). SAMT converts salicylic acid into methyl salicylate, a volatile compound with a wintergreen scent

.

Reporter Module To make it easier to tell when the circuit is active, the same promoter also controls expression of GFP. When the promoter turns on, GFP produces green fluorescence, providing a clear visual signal that the circuit has been activated, even if the odor output is difficult to detect.

Together, these parts form a system that senses sulfur-related chemistry and responds by producing a wintergreen scent, while also providing fluorescence to confirm activation.

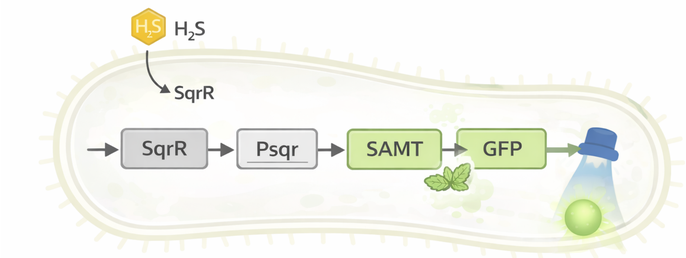

Figure 2: Overview of the engineered genetic circuit. Sulfur input activates Psqr, leading to methyl salicylate production via SAMT and GFP fluorescence as a reporter of circuit activation. *Illustration generated with the assistance of ChatGPT.*

TESTING & VALIDATION STRATEGY

This project is presented as a designed experiment rather than a completed study. The goal of testing is to show that the genetic circuit behaves as intended and responds specifically to sulfur-related chemistry.

To test the system, engineered bacteria carrying the sulfur-responsive circuit are compared under conditions where sulfur is present and absent.

Experiments are carried out using sealed culture vessels or simple skin-mimic setups with simulated sweat chemistry.

Circuit activation is assessed in two ways. GFP fluorescence under blue light is used to confirm that the sulfur-responsive promoter turns on as expected.

Production of methyl salicylate is used to evaluate the functional output of the system by detecting the wintergreen scent in the surrounding air.

Control strains lacking either the sulfur sensor or the SAMT gene are included to confirm that both sensing and output depend on the designed circuit.

Successful validation would show that sulfur exposure leads to promoter activation, visible GFP fluorescence, and conditional production of a wintergreen scent, while these responses remain off in sulfur-absent conditions.

	Sulfur present (+)	Sulfur absent (–)
Engineered strain (with circuit)	✓ GFP fluorescence ✓ Wintergreen scent	✗ GFP fluorescence ✗ Wintergreen scent
Control strain (no circuit)	✗ GFP fluorescence ✗ Wintergreen scent	✗ GFP fluorescence ✗ Wintergreen scent

Figure 3: Expected testing outcomes for the sulfur-responsive genetic circuit. Only engineered bacteria exposed to sulfur are predicted to produce GFP fluorescence and a wintergreen scent. *Diagram generated with the assistance of ChatGPT.*

SPECULATIVE IMPACT

This designed organism reframes body odor as a programmable biological signal. By coupling sensing and actuation, the system demonstrates how engineered microbes could respond dynamically to chemical states in their environment.

More broadly, the project illustrates a synthetic biology approach in which invisible metabolic processes are translated into human-detectable outputs, opening new ways to think about microbial interfaces with the body.

Figure 4: Speculative microbial deodorant concept. *Image generated with the assistance of ChatGPT.*

REFERENCES

Minhas et al., 2025 — *A persulfide-responsive transcriptional circuit mediated by SqrR and Psqr* (bioRxiv) This paper was used to inform the design of the sulfur-sensing module, explaining how the SqrR protein and Psqr promoter respond to sulfur-related signals to control gene expression.
Ross et al., 1999 — *Salicylic acid methyltransferase catalyzes the formation of methyl salicylate in plants* (Archives of Biochemistry and Biophysics) This paper was used to inform the output module, showing how the SAMT enzyme converts salicylic acid into methyl salicylate, the compound responsible for a wintergreen scent.
Chalfie et al., 1994 — *Green fluorescent protein as a marker for gene expression* (Science) This paper was used to inform the reporter module, demonstrating how GFP can be used to visibly indicate when a genetic circuit has been activated.