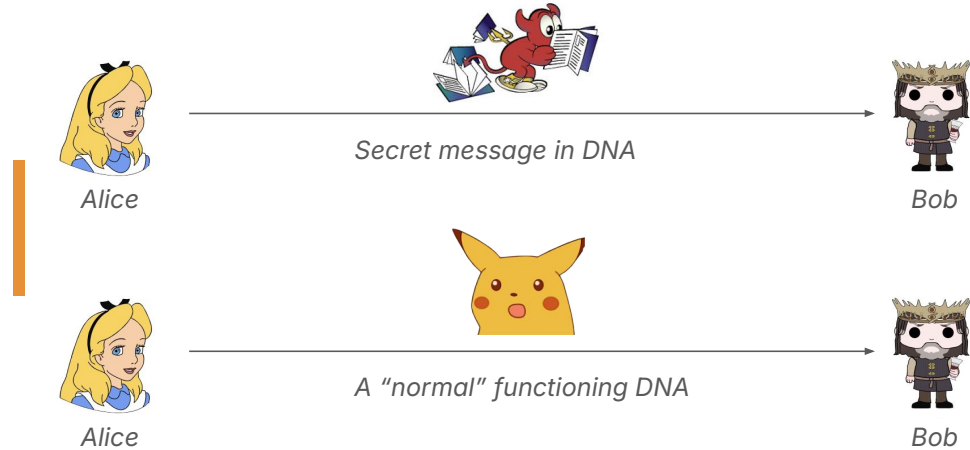


Secret Messaging with DNA Steganography

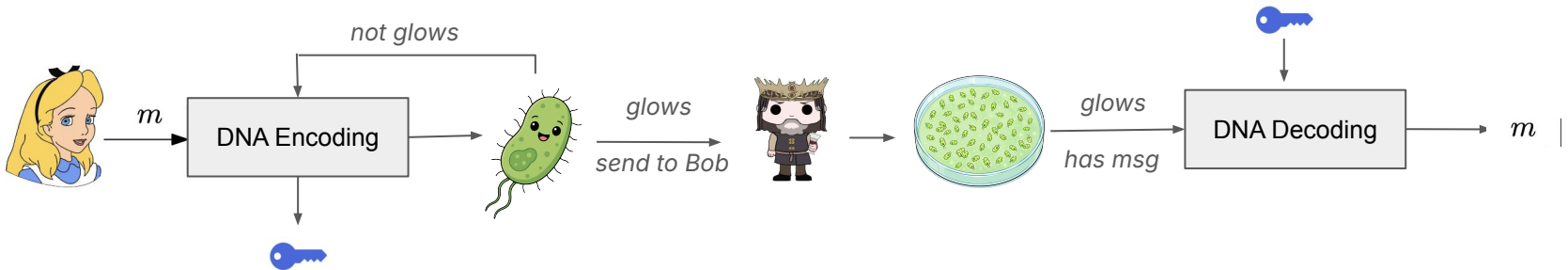
Motivation: DNA communication through a working gene, not a separate entity, enabling uses such as secret messaging, memoirs, and interaction.

Related Work: DNA storage, Watermarking

My Perspective: Borrow the codon-swapping trick from watermarking. Two jobs: produces a protein and carries a message.

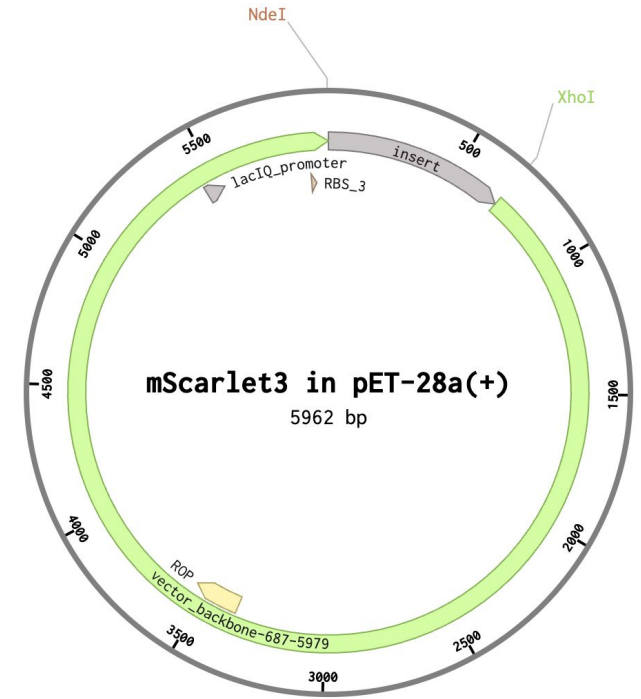
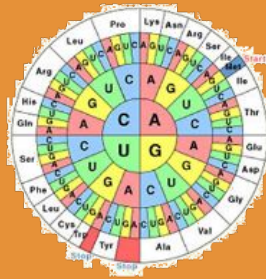


Goal: Develop a practical communication interface for DNA steganography using fluorescent proteins.



Aim 1 . Communication Design + Wet Lab

1. Message → bits (Huffman compress)
2. Codon table: sorted by E. coli favorites (Kazusa K-12).
3. Check with Biopython: Internal NdeI-XhoI, Homopolymer run ≤ 6 nt, and GC content 40–65%
4. Bad score? Rotate bits (01101101 → 10110110 → ...) Good score? Clonal gene Order from Twist in pET-28a(+)



When the Twist order arrives, grow the colony. If it glows -so protein is folded-, Sanger sequence it, then decode with the provided key to recover the message.

ENCODE DECODE HOW IT WORKS

CHOOSE A HOST PROTEIN

mScarlet3 229 aa - 332 bits sfGFP 238 aa - 346 bits

YOUR MESSAGE

Hello from HTGAA! We love growing almost anything.

Capacity 217 / 332 bits

Encode into protein →

SEQUENCE HEALTH

INSERT LENGTH	GC CONTENT	BITS HIDDEN	MAX HOMOPOLYMER	CODON CHANGE RATE
687 nt	52.7%	217	4	41.5%

• Round-trip verified - decode produces exact original message

Aim 2 . Encoding Optimization & Tool Improvements

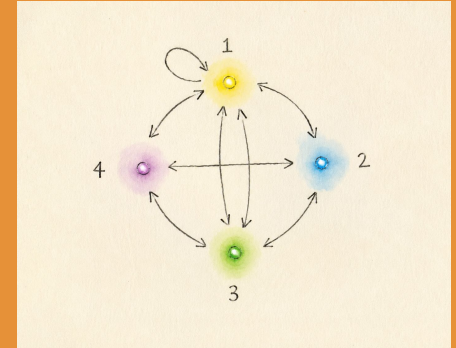
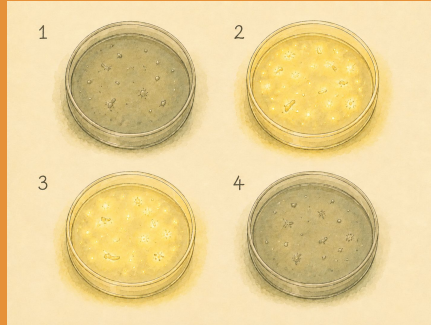
- Encoding optimization
 - Capacity:** *How many more bytes can we fit?*
 - sfGFP (346 bits): ~70-80 characters
 - mScarlet3 (~330 bits): ~65-75 characters
 - Stealth:** *How do we prove the DNA looks like natural E. coli?*
- Support **multiple encoding modes** with side-by-side capacity / stealth / CAI comparison
- Curated **fluorescent protein library** with scaffolds that generate Twist-ready coding sequences

Aim 3 . Talking DNAs



Inspiration: Firefly

Can we avoid sanger sequencing to read the encoded message?



..... .-.. .-.. --- / - --- .- .-

Fluorescent Language

H E L L O / H T G A A