CLAIMS

1. A method of genetically engineering a C1-fixing bacterium comprising introducing into a C1-fixing bacterium containing a DNA molecule comprising a target sequence an engineered, non-naturally occurring Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)/CRISPR-associated (Cas) (CRISPR/Cas) system comprising one or more vectors comprising:

(a) a nucleotide sequence encoding a guide RNA that hybridizes with the target sequence; and

(b) a nucleotide sequence encoding a type-II Cas9 protein under the control of an inducible promoter;

wherein the C1-fixing bacterium is *Clostridium autoethanogenum*.

2. The method of claim 1, wherein the CRISPR/Cas system further comprises on the one or more vectors:

(c) a nucleotide sequence comprising a 5' homology arm that hybridizes upstream of the target sequence and a 3' homology arm that hybridizes downstream of the target sequence,

whereby the 5' homology arm and the 3' homology arm hybridize with the DNA molecule and homologous recombination occurs, resulting in the replacement of the target sequence with DNA located between the 5' homology arm and the 3' homology arm.

3. The method of claim 1 or 2, wherein the Cas9 is catalytically active.

4. The method of claim 1 or 2, wherein the Cas9 is nickase Cas9.

5. The method of claim 1, wherein the Cas9 is catalytically inactive.

6. The method of claim 1 or 2, wherein the Cas9 cleaves the DNA molecule in a region encoding a gene, whereby expression of the gene is decreased.

7. The method of claim 1, wherein the Cas9 blocks the DNA molecule in a region encoding a gene, whereby expression of the gene is decreased.

8. The method of claim 2, wherein the DNA located between the 5' homology arm and the 3' homology arm disrupts the DNA molecule in a region encoding a gene, whereby expression of the gene is decreased.

9. The method of claim 2, wherein the DNA located between the 5’ homology arm and the 3’ homology arm encodes an exogenous gene, whereby the homologous recombination inserts the exogenous gene into the DNA molecule.

10. The method of claim 9, wherein the C1-fixing bacterium expresses the exogenous gene.

11. The method of claim 1, wherein (a) and (b) are located on the same or different vectors.

12. The method of claim 2, wherein (a), (b), and (c) are located on the same or different vectors.

13. The method of claim 1, wherein the CRISPR/Cas system is derived from *Streptococcus pyogenes* or *Streptococcus thermophilus*.

14. The method of claim 1, wherein the inducible promotor is a tetracycline inducible promoter or a lactose inducible promoter.

15. The method of claim 14, wherein the tetracycline inducible promoter is tet3no or ipl12.

16. The method of claim 1, wherein the C1-fixing bacterium is *Clostridium autoethanogenum* LZ1561, which is deposited under DSMZ accession number DSM23693.