CLAIMS

What is claimed is:

1. A synthetic microorganism engineered at genome level for enhanced bioleaching comprising a heterologous hcnABC operon integrated in the synthetic microorganism's genome that results in enhanced cyanide production by the microorganism, wherein

the heterologous hcnABC operon is not subject to quorum control;

the cyanide production is decoupled from quorum control through use of exogenous promoters, *pBAD* and *pTAC*; and

the microorganism is *Chromobacterium violaceum*.

2. The synthetic microorganism of Claim 1, wherein the *Chromobacterium violaceum* is ATCC accession number ATCC 12472 transformed with the heterologous hcnABC operon.

3. A synthetic microorganism engineered for enhanced bioleaching comprising a heterologous hcnABC operon contained on an extragenomic plasmid that results in enhanced cyanide production by the microorganism, wherein

the heterologous hcnABC operon is not subject to quorum control;

the cyanide production is decoupled from quorum control through use of exogenous promoters, *pBAD* and *pTAC*; and

the microorganism is *Chromobacterium violaceum*.

4. The synthetic microorganism of Claim 1, wherein the hcnABC operon is integrated in the synthetic microorganism's genome by site-specific genomic integration.

5. The synthetic microorganism of Claim 4, wherein the site-specific genomic integration is by Tn7-mediated transposition.

6. The synthetic microorganism of Claim 5, wherein the site-specific integration is at the glmS locus.

7. The synthetic microorganism of any one of the preceding claims, wherein the heterologous hcnABC operon comprises a heterologous regulatory sequence in operative association with an hcnABC operon.

8. The synthetic microorganism of Claim 7, wherein the heterologous regulatory sequence is an inducible regulatory sequence.

9. The synthetic microorganism of Claim 8, wherein the inducible regulatory sequence is selected from an IPTG (isopropylthiogalactoside)-inducible, L-arabinose-inducible, tetracycline-inducible, lactose-inducible, N-acyl homoserine lactone-inducible, propionate-inducible, rhamnose-inducible, hypoxia-inducible, or galactose-inducible regulatory sequence.

10. The synthetic microorganism of Claim 9, wherein the inducible regulatory sequence is selected from an IPTG-inducible or L-arabinose-inducible regulatory sequence.

11. The synthetic microorganism of any one of the preceding claims, wherein the heterologous hcnABC operon is an endogenous hcnABC operon in operative association with a heterologous inducible regulatory sequence.

12. The synthetic microorganism of any one of Claims 1-10, wherein the heterologous hcnABC operon is a heterologous hcnABC operon in operative association with a heterologous inducible regulatory sequence.

13. The synthetic microorganism of any one of the preceding claims, wherein the microorganism comprises 1, 2, 3, 4, 5, 6, 7, 8, or more heterologous hcnABC operons.

14. The synthetic microorganism of any one of the preceding claims, wherein the microorganism is hypomorphic for cyanate hydratase.

15. The synthetic microorganism of any one of the preceding claims, wherein the microorganism is placed into contact with a pulp comprising one or more metals under conditions for enhanced cyanide production by the heterologous hcnABC operon.

16. The synthetic microorganism of Claim 15, wherein the pulp has been pretreated by oxidation.

17. The synthetic microorganism of Claim 16, wherein the oxidation is by biooxidation.

18. The synthetic microorganism of Claim 17, wherein the biooxidation is with a microorganism capable of redox-based biooxidation, such as *Acidithobacillus ferrooxidans*.

19. The synthetic microorganism of any one of Claims 15-18, wherein the pulp density is between about 0.1 to about 5.0 % (W/V).

20. The synthetic microorganism of any one of Claims 15-19, wherein the pulp comprises particles with an average diameter of about: 5, 10, 12.5, 25, 50, 75, 100, 125, 150, 175, 200 µm, or less.

21. The synthetic microorganism of Claim 18, wherein the pulp comprises particles with an average diameter of less than about 100 µm.

22. The synthetic microorganism of any one of Claims 15-21, wherein the pulp comprises a mineral ore.

23. The synthetic microorganism of any one of Claims 15-22, wherein the pulp comprises electronic scrap material (ESM).

24. The synthetic microorganism of any one of Claims 15-23, wherein the one or more metals include one or more of gold, silver, platinum, copper, aluminum, nickel, zinc, iron, rare earths elements, other heavy metals, or a combination thereof.

25. A method of recovering one or more metals from a pulp comprising contacting the pulp with the synthetic microorganism of any one of Claims 1-22 under conditions for enhanced cyanide production by the heterologous hcnABC operon to solubilize the one or more metals and isolating the one or more solubilized metals.

26. A method of recovering gold from a pulp comprising electronic scrap material (ESM) comprising contacting the pulp with the synthetic microorganism of any one of Claims 1-22 under conditions for enhanced cyanide production by the heterologous hcnABC operon to solubilize the gold and isolating the solubilized gold.