Whole-Cell-Catalyzed Carbenoid B–H Insertion

**Significance:** The Arnold group reports a whole-cell-catalyzed organoboron synthesis through carbenoid B–H insertion. Identification of an appropriate boron reagent that is stable and active under physiological conditions and site-saturation mutagenesis of the wild-type cytochrome c from *Rhodothermus marinus* to afford a series of *Escherichia coli* cells that catalyze the desired transformation permitted the synthesis to be performed with remarkable turnover numbers and enantioselectivities. Interestingly, lower turnover frequencies were obtained by using either purified protein or cell lysate. Turnover numbers could be increased up to 15300 TTN by portionwise addition of substrates.

**Comment:** Chiral organoboron compounds are versatile synthetic intermediates, and therefore their asymmetric synthesis is of great interest. However, no organism is known to form the desired C–B bond. As a continuation of their previous work on enzyme-catalyzed carbenoid insertions (*Science* 2016, 354, 1048), the authors again impressively demonstrate that selective DNA modification can produce microorganisms that are able to achieve this unnatural bond formation in high efficiency (up to 400 times more active than published metal-catalyzed systems) and with high selectivity.

**Selected examples:**

- **BH2 OEt**
  - 75% yield
  - 3000 TTN
  - er = 97.5:2.5

- **BH2 OEt**
  - 890 TTN
  - er = 96:4

- **BH2 OEt**
  - 1070 TTN
  - er = 96:4

- **BH2 OMe**
  - 2760 TTN
  - er = 98:2

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Further modification and synthetic application:

- **BH2**
  - Using BOR1
  - 1120 TTN
  - er = 90:10

- **BH2**
  - Using BOR2
  - 70% yield (brsm)
  - 1010 TTN
  - er = 96:4

**Key words**

- organoboranes
- carbenoid insertion
- mutagenesis
- directed evolution