Magnetotactic bacteria (mtb) migrate along geomagnetic field lines, i.e., they behave like self-propelled magnetic compass needles. Mtbs make single-magnetic-domain crystals of magnetite (Fe₃O₄) and greigite (Fe₃S₄) in intracellular structures called magnetosomes. The magnetosomes are arranged in linear chains that comprise permanent magnetic dipoles with remanent moments approaching the saturation moment, causing the mtbs to be oriented in the geomagnetic field as they swim. This allows them to keep their heading and efficiently migrate to, and remain in, a preferred, microaerobic, aquatic habitat. The mtbs have solved the difficult problem of designing a permanent magnet that is sufficiently robust to cause the cell to be oriented in the geomagnetic field at ambient temperature, yet fit inside a micron-sized object, and be assembled in situ from potentially toxic materials scavenged from the environment. I will describe some recent advances in mtb genetics that illuminate the process by which they make and arrange their magnetosomes.