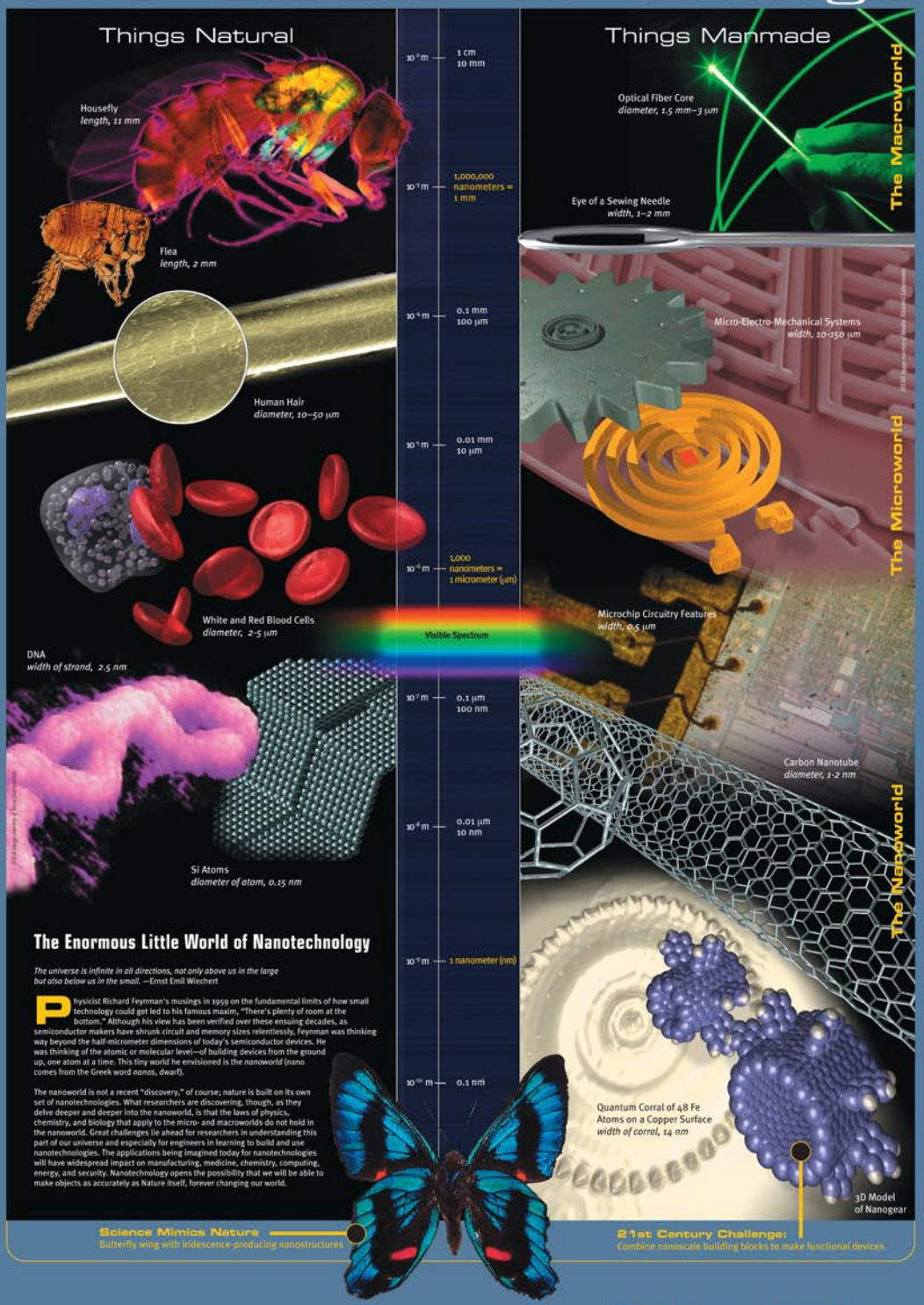
Macro • Micro • Nano

The Scale of Things



The Enormous Little World of Nanotechnology

The universe is infinite in all directions, not only above us in the large but also below us in the small. —Ernst Emil Wiechert

Physicist Richard Feynman's musings in 1959 on the fundamental limits of how small technology could get led to his famous maxim, "There's plenty of room at the bottom." Although his view has been verified over these ensuing decades, as semiconductor makers have shrunk circuit and memory sizes relentlessly, Feynman was thinking way beyond the half-micrometer dimensions of today's semiconductor devices. He was thinking of the atomic or molecular level—of building devices from the ground up, one atom at a time. This tiny world he envisioned is the *nanoworld* (nano comes from the Greek word *nanos*, dwarf).

The nanoworld is not a recent "discovery," of course; nature is built on its own set of nanotechnologies. What researchers are discovering, though, as they delve deeper and deeper into the nanoworld, is that the laws of physics, chemistry, and biology that apply to the micro- and macroworlds do not hold in the nanoworld. Great challenges lie ahead for researchers in understanding this part of our universe and especially for engineers in learning to build and use nanotechnologies. The applications being imagined today for nanotechnologies will have widespread impact on manufacturing, medicine, chemistry, computing, energy, and security. Nanotechnology opens the possibility that we will be able to make objects as accurately as Nature itself, forever changing our world.

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