Lesson 12: Eukaryotes

For two billion years, every living thing on Earth was a prokaryote, a simple cell with no complex internal structure. Then, about 1.7 billion years ago, a new kind of cell appeared. This cell had something that none of its ancestors had possessed: a **nucleus**, a compartment sealed off by its own membrane, where the cell's **DNA** was protected and organized. The nucleus acted as a command center, directing everything the cell did. Cells with a nucleus are called **eukaryotes**, and their appearance was one of the most important events in the entire history of life.

But the nucleus was not the only new feature. Eukaryotic cells also developed **organelles**, specialized structures inside the cell, each performing a particular job, like organs in a tiny body. The most important are the **mitochondria**, which act like power stations, converting food into energy the cell can use. The **cell membrane** controls what enters and leaves, protecting the organized interior. And plant cells developed chloroplasts, structures that capture sunlight for photosynthesis.

Here is one of the most astonishing discoveries in biology: mitochondria were once free-living bacteria. Billions of years ago, a larger cell engulfed a smaller one, and instead of digesting it, the two began working together in a partnership called **endosymbiosis**. The small cell provided energy; the large cell provided shelter. Over time, they became one. The evidence is extraordinary: mitochondria still carry their own separate DNA, a ghost of their ancient independence, distinct from the nucleus's DNA. The cells in your body today carry the descendants of a billion-year-old bacterial partnership.

Every plant, every animal, every fungus, and every human being is made of eukaryotic cells. This one invention, a cell with a nucleus and specialized internal parts, unlocked the door to all complexity that followed. Without eukaryotes, there could be no multicellular life, no plants, no animals, nothing with more than one cell working as a whole. Everything that makes the living world rich and beautiful traces back to this one ancient transformation.