

The cellular and genomic organization of prokaryotes is fundamentally different from that of eukaryotes

- Prokaryotic cells lack a nucleus enclosed by membranes.
- The cells of prokaryotes also lack the other internal compartments bounded by membranes that are characteristic of eukaryotes.
- Instead, prokaryotes used infolded regions of the plasma membrane to perform many metabolic functions, including cellular respiration and photosynthesis.
- Prokaryotes have smaller, simpler genomes than eukaryotes.
 - On average, a prokaryote has only about one-thousandth as much DNA as a eukaryote.
- Typically, the DNA is concentrated as a snarl of fibers in the **nucleoid region**.
- The mass of fibers is actually the single prokaryotic chromosome, a double-stranded DNA molecule in the form of a ring.
 - There is very little protein associated with the DNA.
- Prokaryotes may also have smaller rings of DNA, called **plasmids**, that consist of only a few genes.
 - Prokaryotes can survive in most environments without their plasmids because essential functions are programmed by the chromosome.
 - However, plasmids provide the cell genes for resistance to antibiotics, for metabolism of unusual nutrients, and other special functions.
 - Plasmids replicate independently of the chromosome and can be transferred between partners during conjugation.
- Although the general processes for DNA replication and translation of mRNA into proteins are alike for eukaryotes and prokaryotes, some of the details differ.
 - For example, the prokaryotic ribosomes are slightly smaller than the eukaryotic version and differ in protein and RNA content.
 - These differences are great enough that selective antibiotics, including tetracycline and chloramphenicol, can block protein synthesis in many prokaryotes but not in eukaryotes.

Populations of prokaryotes grow and adapt rapidly

- Prokaryotes reproduce only asexually via **binary fission**, synthesizing DNA almost continuously.
- A single cell in favorable conditions will produce a colony of offspring.
- While lacking meiosis and sexual reproduction as seen in eukaryotes, prokaryotes have several mechanisms to combine genes between individuals.
 - In **transformation**, a cell can absorb and integrate fragments of DNA from their environment.
 - This allows considerable genetic transfer between prokaryotes, even across species lines.
 - In **conjugation**, one cell directly transfers genes to another cell.
 - In **transduction**, viruses transfer genes between prokaryotes.

- Lacking meiotic sexual reproduction, **mutation** is the major source of genetic variation in prokaryotes.
 - With generation times in **minutes or hours**, prokaryotic populations can adapt *very rapidly* to environmental changes, as natural selection screens new mutations and novel genomes from gene transfer.
- The word *growth* as applied to prokaryotes refers to multiplication of cells and population increases, rather than enlargement of individual cells.
- Conditions for optimal growth vary according to species.
 - Variables include temperature, pH, salt concentrations, nutrient sources, among others.
- In the absence of limiting resources, growth of prokaryotes is effectively geometric.
 - The number of cells doubles each generation.
 - Typical generation times range from 1-3 hours, but some species can double every 20 minutes in an optimal environment.
- Prokaryotes can also withstand harsh conditions.
- Some bacteria form resistant cells, called **endospores**.
 - In an endospore, a cell replicates its chromosome and surrounds one chromosome with a durable wall.
 - While the outer cell may disintegrate, an endospore, such as this anthrax endospore, dehydrates, does not metabolize, and stays protected by a thick, protective wall.
- An endospore is resistant to all sorts of trauma.
 - Endospores can survive lack of nutrients and water, extreme heat or cold, and most poisons.
 - Sterilization in an autoclave, however, kills endospores by heating them to 120°C.
 - Endospores may be dormant for centuries or more.
 - When the environment becomes more hospitable, the endospore absorbs water and resumes growth.