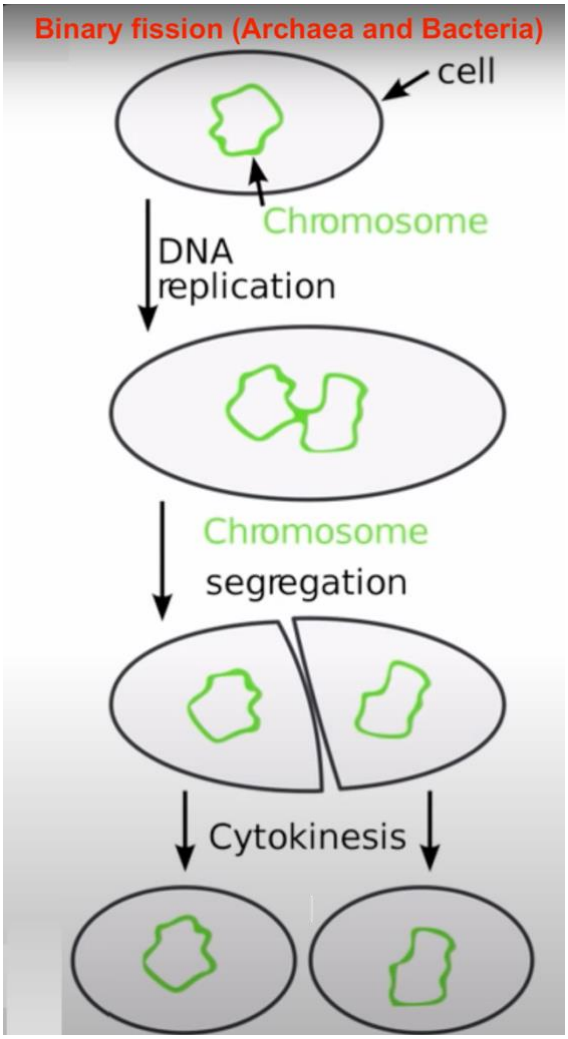
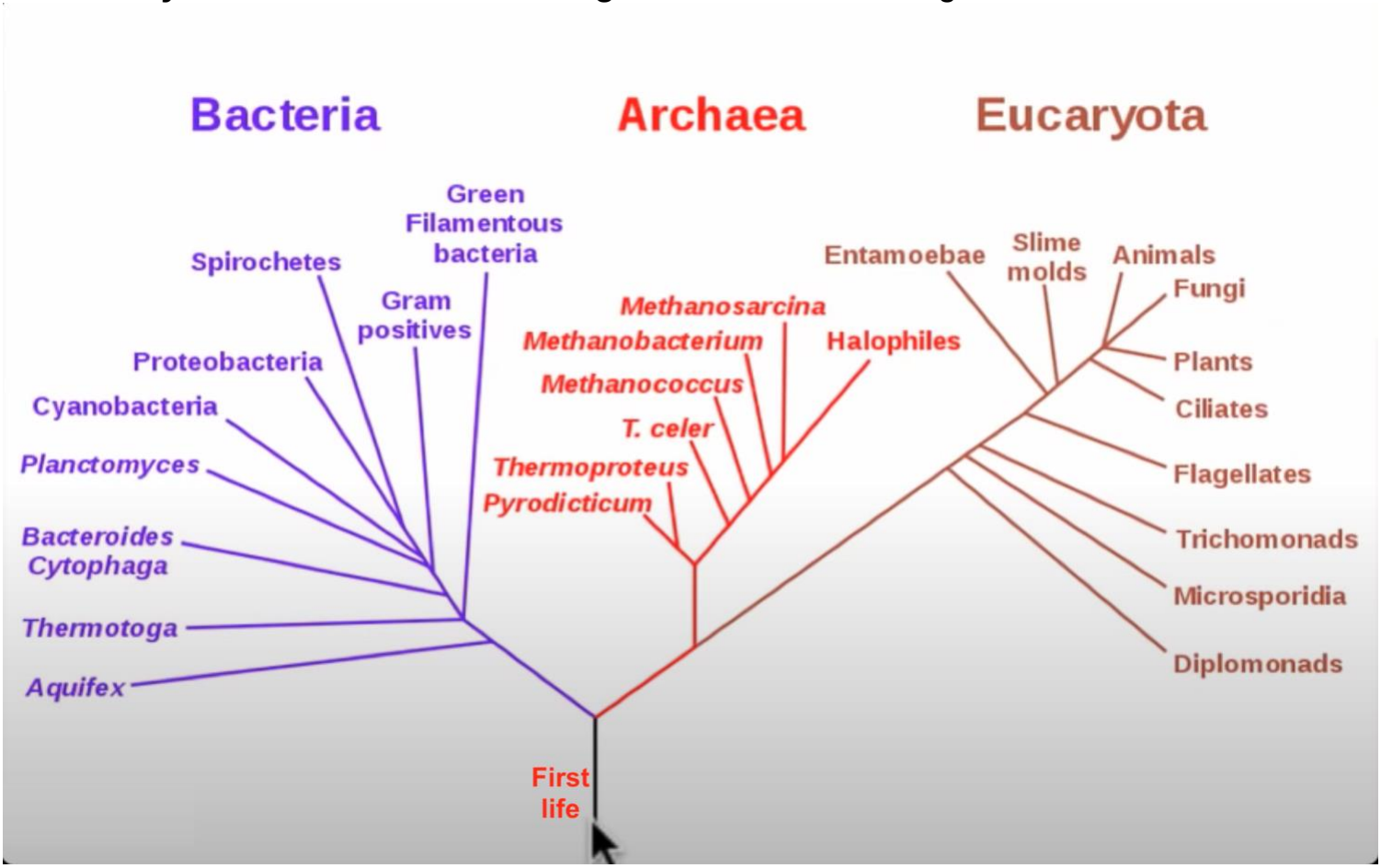
recombination

Life started when complex membrane-enclosed structures containing nucleic acids and proteins began to sustainably metabolize and replicate. These were the first cells, *prokaryotes*: single-celled organisms which do not have a nucleus. Prokaryotes reproduce by *binary fission*, in which one cell divides into two. As DNA replication occurs prior to division, rare mutational errors can result in progeny cells which are viable, but slightly different.

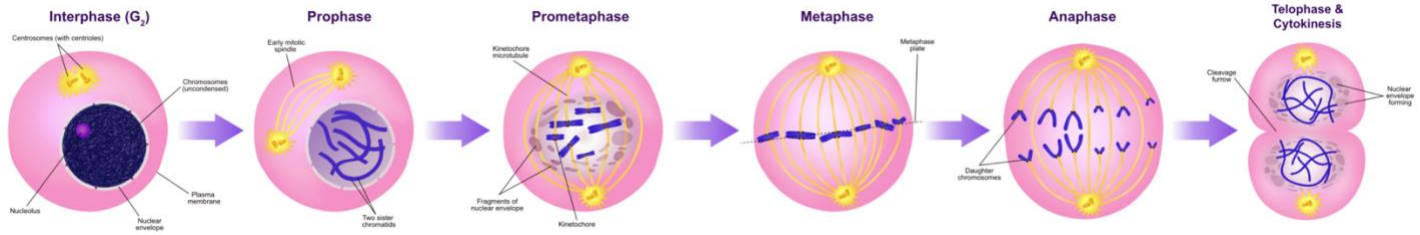


Occasionally, useful genetic mutants arise which are better able to survive in the existing local environment than is their parent cell. These variants then reproduce more successfully and became dominant. This is one method of variation and natural selection: *evolution*. In addition, *lateral transfer* of DNA from one cell to another episodically occurs. Over time, diverse *species* (L. **species**: "appearance") of unicellular organisms have arisen, each suited to optimally flourish in its local microenvironment.

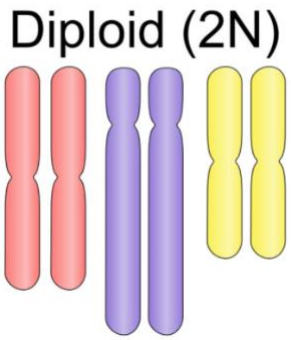
For 2,000,000,000 years, the only life on earth was unicellular and prokaryotic: two domains, **Archaea** and **Bacteria**, ruled. Diversification and appearance of new species was very slow but steady over the vast eons of time. Then, about 1,800,000,000 years ago, certain bacterial cells entered certain Archaean cells and took up *symbiotic residence*, becoming mitochondria and dividing along with the host cell whenever it split to become two. This new type of cell developed a membrane-enclosed nucleus, in which genetic material was organized in chromosomes. Thus began the third branch of life, **Eukaryota: Protists**, **Plants**, **Fungi**, and **Animals** belong to this domain.



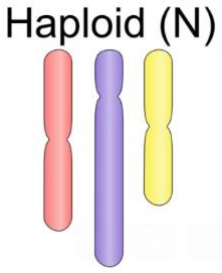
When *individual cells* of *eukaryotic* organisms reproduce, chromosomes first duplicate, then line up along the center of the cell, and separate equally, pulled apart by contractile spindle fibers in a process called mitosis (Gk. **μίτος**: "thread"). Membranes, cell content, and chromosomes are divided equally as the original eukaryotic cell becomes two.



Then, just 1,200,000,000 years ago, another form of reproduction became common, transforming the landscape of genetic diversity and greatly accelerating the origin of species. Sexual reproduction results from the merging of haploid cells from two individuals to form a diploid zygote, initiating growth of an offspring. Each parent individual is a *diploid* (Gk. ***διπλόος***: "*twofold"*) organism, which has a nucleus containing two sets of chromosomes, inherited from its own parents.



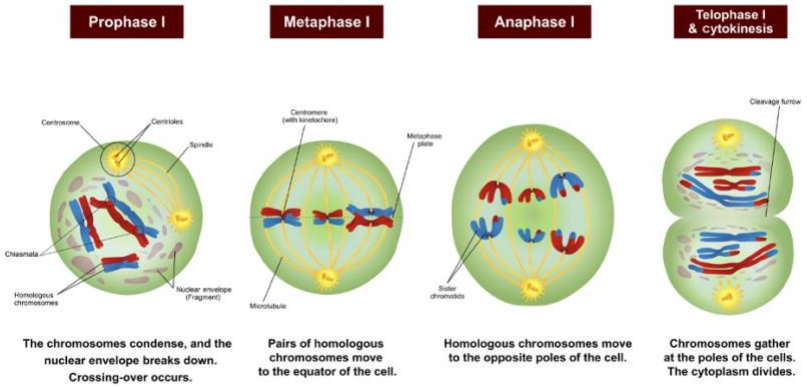
When reproductive cells (*gametes*: eggs and sperm) are formed, there is a reduction by half in chromosomes, so that gametes are haploid (Gk. **απλοειδές**: "*onefold"*).



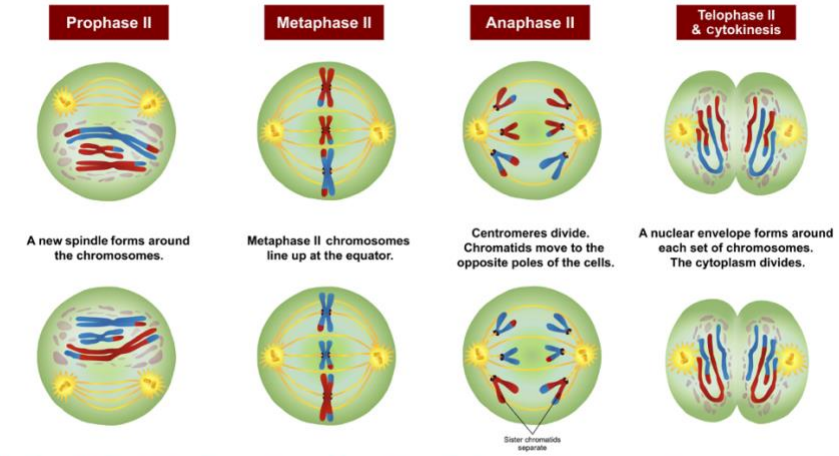
During the first step in **meiosis** (Gk. **μείωσις**: "lessening"), the cell division process in which gametes are formed, there is rearrangement of portions of each chromosome, called ***recombination***. As a result, when gametes merge ("fertilization" - *cell fusion*), each resulting zygote is genetically similar, but not identical to other zygotes. ******* Rearrangement of genetic content in the chromosomes of organisms in each generation provides *genetic variation* and is what allows *eukaryotic organisms* to rapidly adapt when living conditions change. *Sexual reproduction* became common about 1,000,000,000 years ago. ***

MEIOSIS

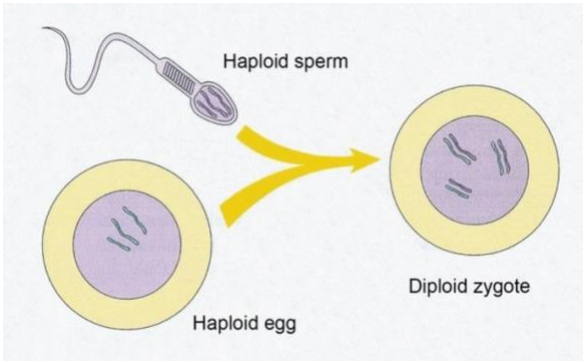
from Greek μείωσις: "lessening"
(because the chromosome number is reduced by half)



***** In the first step of meiosis - Prophase I - **genetic recombination** occurs.**



***** One (1) diploid cell produces four (4) cells: haploid gametes (eggs or sperm), each with **recombinant** genomes.*****



The **recombination** of genetic material that occurs every time a *gamete* is formed and the novel combination of chromosomes that results when two gametes fuse to form a *zygote* is the basis for the extraordinary diversity of eukaryotic life that has occurred over the past billion years. Multicellular animals came into prominence 540,000,000 years ago ("*Cambrian explosion*"). Sexual reproduction / ***recombination*** *has been the primary driver of accelerated species development for all this time*.