

I. Nuclear genome characteristics of microbial eukaryotes

- A. Can be haploid, diploid or diploid/haploid phase may alternate (alternation of generations with a sporophyte and gametophyte generations) like yeast.
- B. Type of reproductive behavior-eukaryotic microbes may be self-fertile, self-sterile (outcrossing), both or only asexual. Reproduction mostly occurs by conjugation. Transfer of nuclear material or whole cell fusion.
- C. Parasexual genetics and mitotic crossing over
- Many microbial eukaryotes do not undergo sexual reproduction and yet show great genetic differences. Many sexual and asexual species are capable of undergoing parasexual cycle. Analogous to meiotic recombination and requires some of the enzymes required for meiotic recombination, but occurs at a much lower frequency.

II. Chromosome/plasmids

- A. Chromosome polymorphisms observed in populations
- B. Supernumerary chromosomes
 - Small chromosomes “B” that can be lost with no phenotypic effect. Extremely common. Some virulence or pathogenicity genes are located on supernumerary chromosomes (analogous to vir plasmids in bacteria).
- C. Unusual genetics Micro and macronucleus in ciliates
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 - Ciliates are diploid and have one micro diploid nucleus that only participates during sexual reproduction (no transcription). Genes in the micronucleus in some species are completely scrambled. During macronucleus formation, sequences and orientation of the genes is restored. Macronuclei contain numerous copies of transcribed genes (greater than 1000 copies).

II. Transposable elements

- Unlike bacterial transposons, most characterized microbial eukaryote transposons depend on an RNA intermediate for transposition. TY element in yeast, uses reverse transcriptase to make an RNA intermediate that is important in transposition, which was tested by the insertion of an intron into TY. LINE-like elements in filamentous fungi can be infectious—RNA intermediate can travel in the cytoplasm and infect a “naïve” nucleus.

III. Extranuclear inheritance (mitochondria, chloroplasts and symbiotic bacteria in Paramecium.

- A. Mitochondrial genetics
 - Exhibit maternal inheritance (cytoplasmic inheritance). In yeast, petite mutants have dysfunctional mitochondria. Yeast can survive because can undergo aerobic and anaerobic respiration. Petite mutants show non-mendelian ratio of progeny that is strain-specific.

Mitochondrial mutations can be mapped because mitochondria undergo fusion, recombination and cytoplasmic segregation.

- B. Many linear or circular plasmids found in mitochondria of microbial eukaryotes. These also show cytoplasmic inheritance—senescence plasmids in *Neurospora* and *Podospora*.
- C. Chloroplast genetics in *Chlamydomonas*; type of mitochondria inherited is dependent upon mating type.
- D. Killer phenomenon in *Paramecium*
 - “Killer” *Paramecium* liberate a toxin into the environment (or during conjugation) that kill “killer-minus” cells. Crosses showed cytoplasmic inheritance phenotype (all had it or didn’t; no 1:1 segregation)-termed “Kappa”. Determined that many species of bacterial symbionts are present in *Paramecium*, that have a restricted cellular location, some in micronuclei, some in macronuclei and most in the cytoplasm. The bacteria produce toxin and antidotes associated with killer phenomenon.

V. Non-mendelian segregation of traits

- A. Sporekiller and meiotic drive. During a cross between a sporekiller+ and sporekiller -, all sporekiller minus progeny are killed. Nuclear-encoded gene.

VI. Epigenetic phenomenon

- A. Silencing mechanisms
 - Chromatin mechanisms associated with gene location (telomeres) in yeast.
- B. HGDs Homology dependent gene silencing
 - Co-suppression mechanism whereby genes are silenced because of the formation of an aberrant RNA that causes targeting degradation of mRNA.
- C. RIPing/silencing
 - Inactivation of repeated sequences in the genome by methylation (inactivates via eliminating transcription; inhibits initiation and blocks elongation) and/or mutation (GC-AT transition mutations). Silencing by methylation common in protists that have been analyzed; RNAi independent.
- D. Prions
 - Cytoplasmically-mediated inheritance [PSI] and [URE3] in yeast. Infectious agent is a protein that is in an altered form that is self-propagating and infectious. Interaction can trigger conversion of normal cellular form to altered state.
 - Example: [het-s] in *P. anserina*
 - Crosses between [het-s; prion form, causes PCD when interacts with het-S strain] and [het-s*; neutral form] show maternal inheritance. Heterokaryons formed between [het-s] and [het-s*] result in the conversion of [het-s*] to [het-s], infectious. [het-s*] is cytoplasmic, resistant to proteases and forms amyloid aggregates inside the cell.