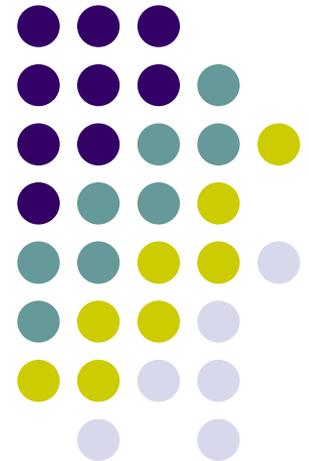


Organization of the genetic material, chromosomes, chromatids

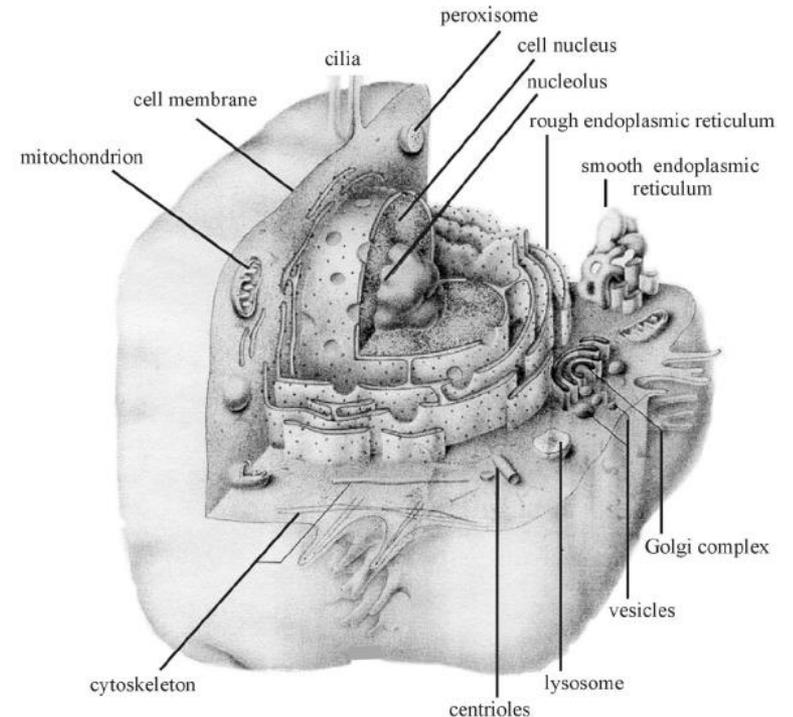
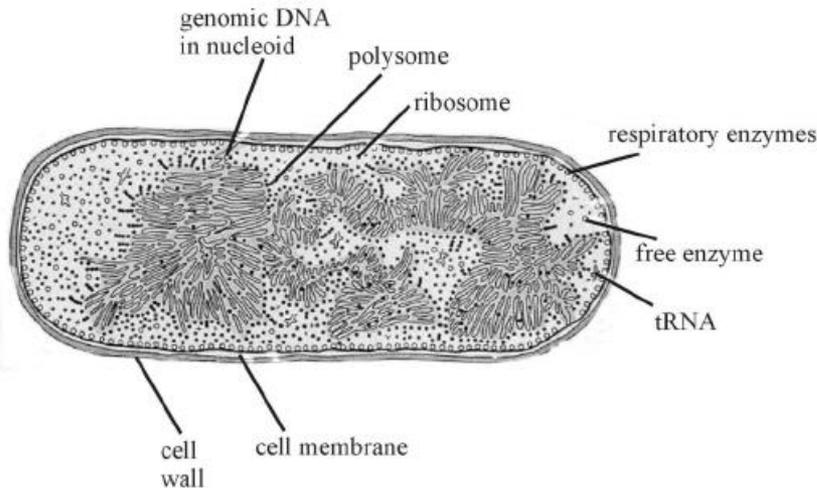
Oktavia Tarjanyi M.D.
Gergely Berta M.D.





Location of the genetic material

- Prokaryotes: in the cytoplasm → nucleoid
- Eukaryotes: in the nucleus → chromatin



Why do eukaryotes have chromatin?

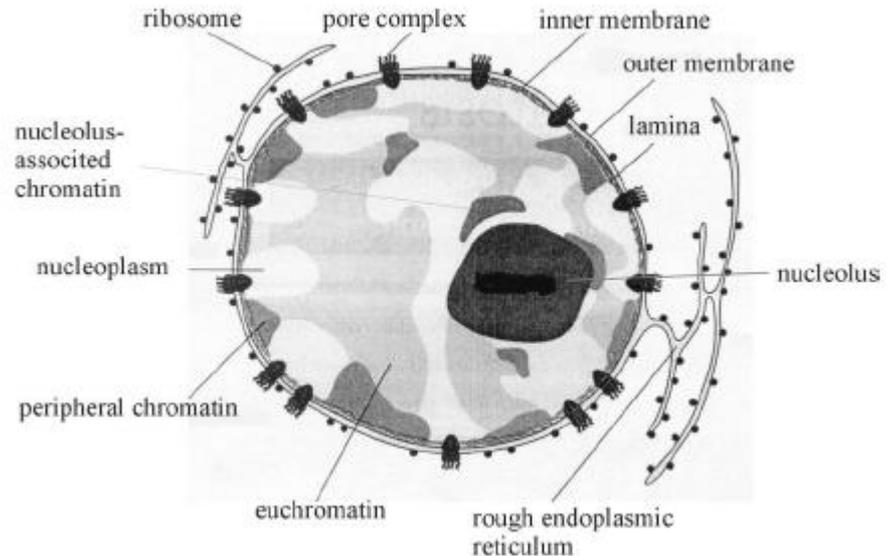


- Chromatin is a packaged form of the DNA into a smaller volume to fit in the cell
- Proteins of the chromatin strengthen the DNA and allow mitosis and meiosis because they allow the formation of the chromosomes.
- Proteins of the chromatin serve mechanisms to control gene expression.

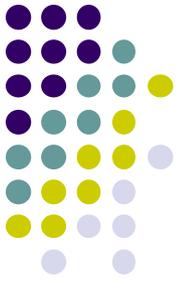
Chromatin



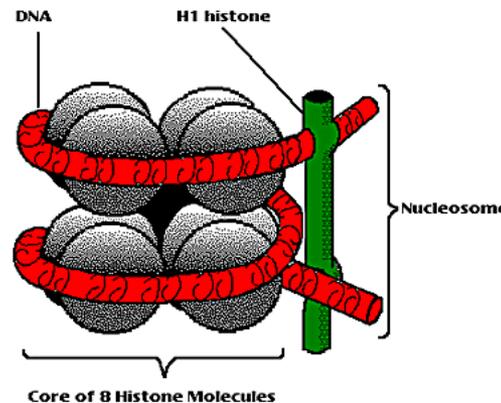
- only in eukaryotic cells
- in non-dividing cells (in the interphase)
- euchromatin: transcriptionally active
- heterochromatin: transcriptionally inactive
 - perinucleolar/nucleolus-associated
 - peripheral/marginal
 - diffuse



Chromatin organization

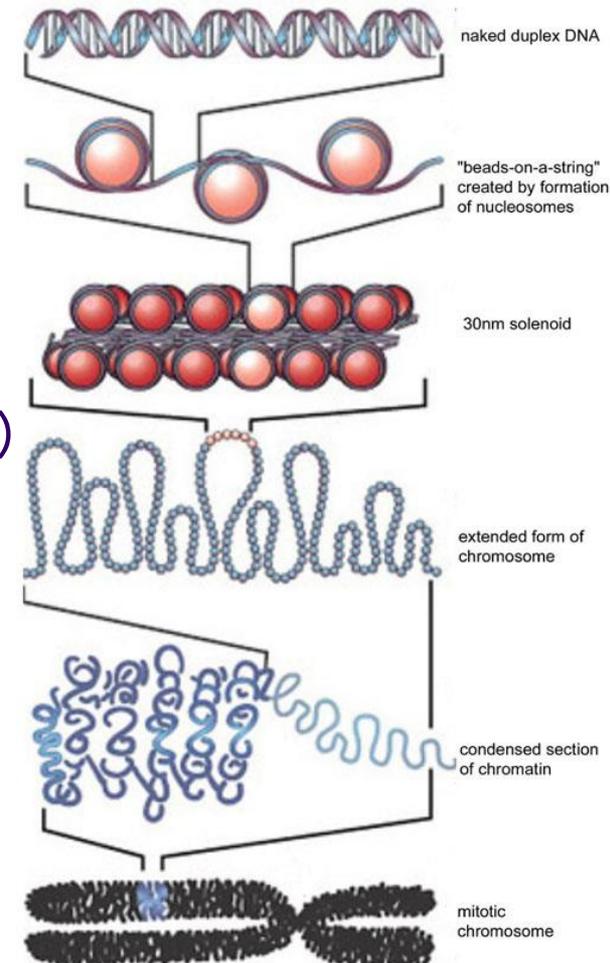


- condensation: chromatin becomes more compact
- levels:
 - DNA double helix
 - beads-on-a-string:
 - nucleosome: histone octamer + DNA
 - linker DNA
 - (chromatosome: nucleosome + H1 histone)
 - solenoid
 - looped domains
 - chromosome

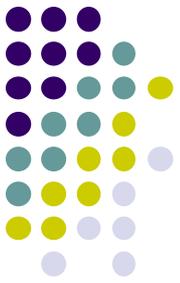


Nucleosome

<http://www.accessexcellence.com/AB/GG/nucleosome.gif>



The chemical composition of chromatin



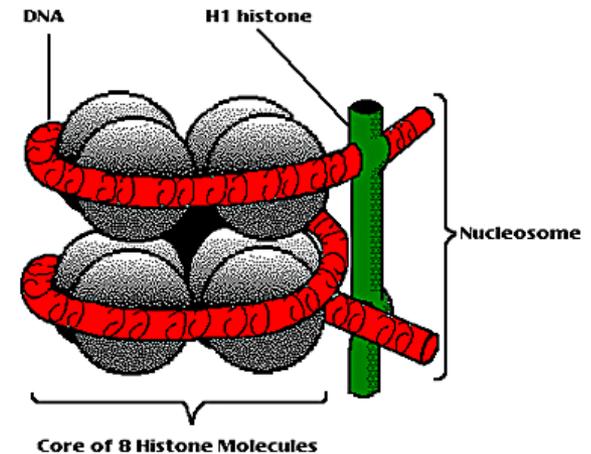
- DNA
- Proteins
 - Histones
 - Nonhistone proteins
- RNA
 - Pre-mRNA, mature mRNA
 - rRNA
 - tRNA ...etc.
- inorganic ions
 - Mg^{++}
 - Ca^{++}



Proteins of chromatin I.

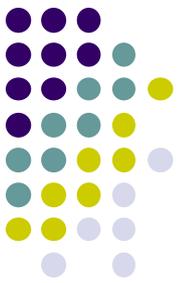
Histone proteins

- basic proteins (rich in Lysine, Arginine)
 - Nucleosomal histones (H2A, H2B, H3, H4)
 - octamer in nucleosome
 - H1 histone
 - outside the nucleosome
 - induces solenoid formation
- are highly conserved
- structural function
- regulation of gene expression
- chemical modifications
 - Phosphorylation → chromatin condensation
 - Acetylation → chromatin **de**condensation



Nucleosome

<http://www.accessexcellence.com/AB/GG/nucleosome.gif>

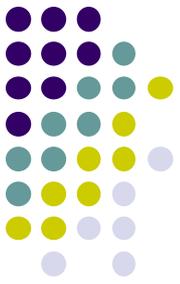


Proteins of chromatin II.

Nonhistone proteins

- tissue-specific expression
- different in structure
- different in function
 - Structural proteins (e.g. lamins)
 - Enzymes (e.g. DNA, RNA polymerases)
 - Transcription factors
 - Receptor proteins (e.g. steroid receptors)
 - Transport proteins (e.g. importin)
 - Chaperones (e.g. nucleoplasmin)

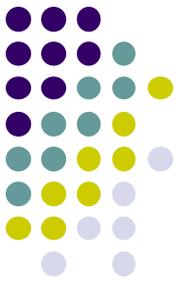
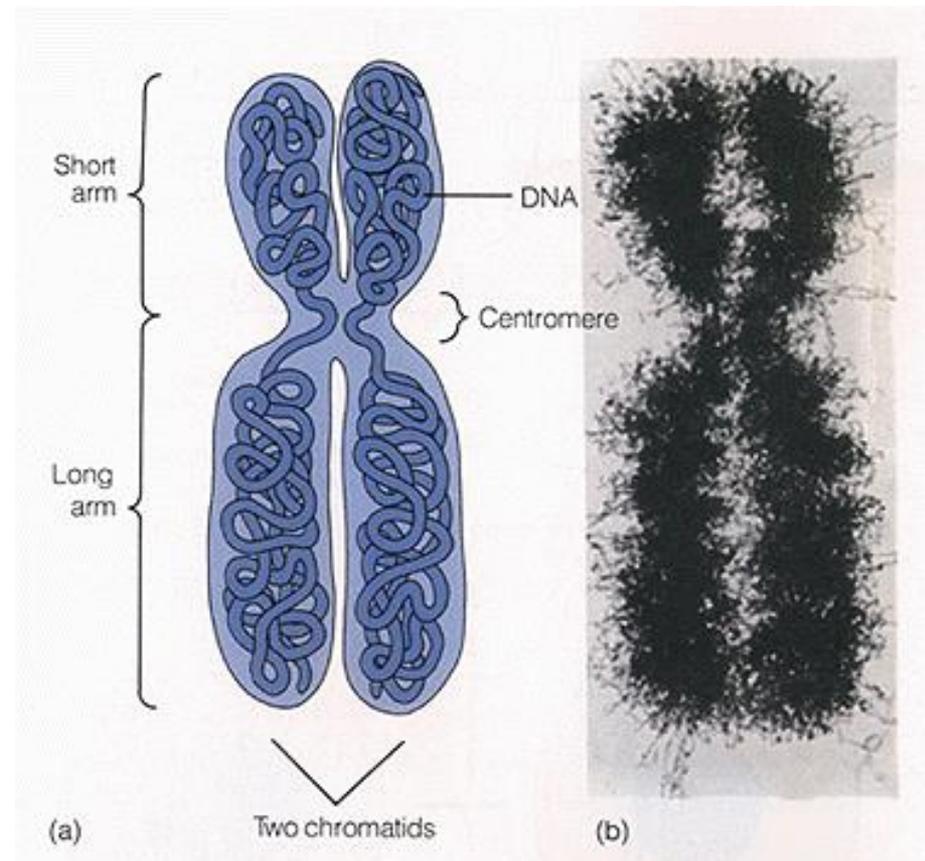
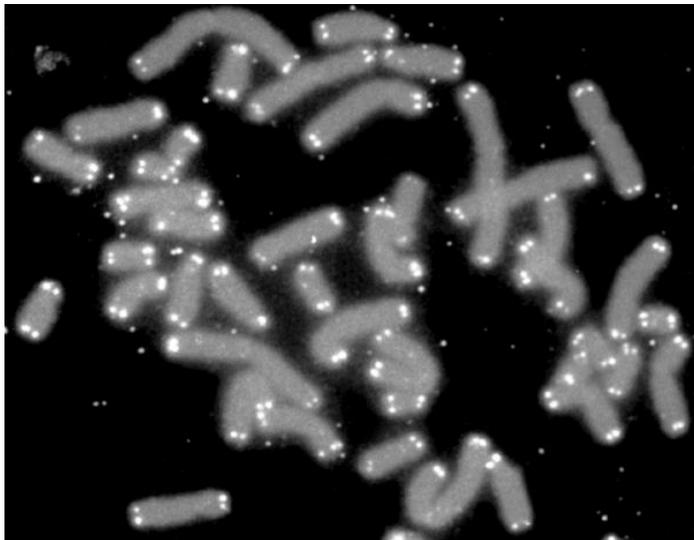
Genetic terms associated with chromosomes



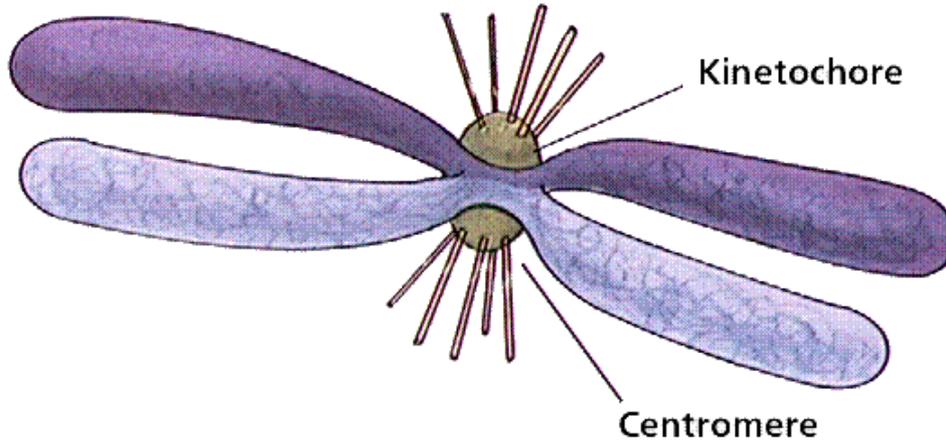
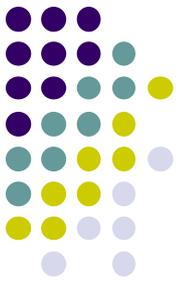
- **Gene:** region of DNA that codes for a protein
- **Locus:** the site of a gene in a chromosome
- **Homologous chromosomes:** members of a chromosome pair
- **Somatic chromosomes/autosomes:** 1-22
- **Sex chromosomes:** X, Y

Chromosomes

- chromatids
- centromere
- telomeres
- short (p) and long (q) arm

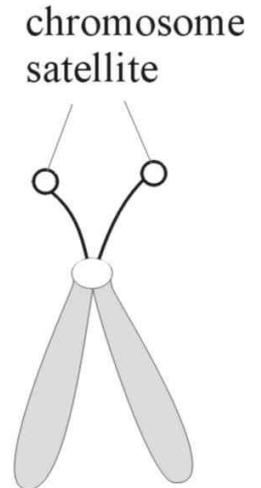
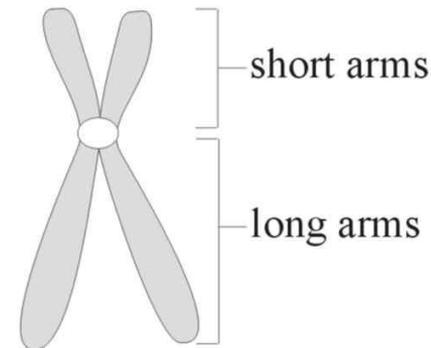
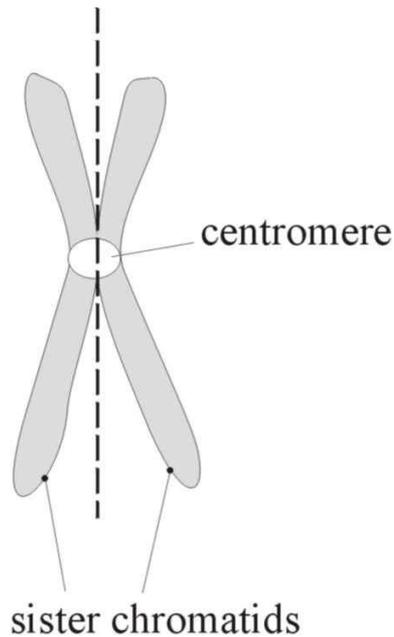


Chromosomes II.



- types (based on the position of the centromere):

- metacentric
- submetacentric
- acrocentric

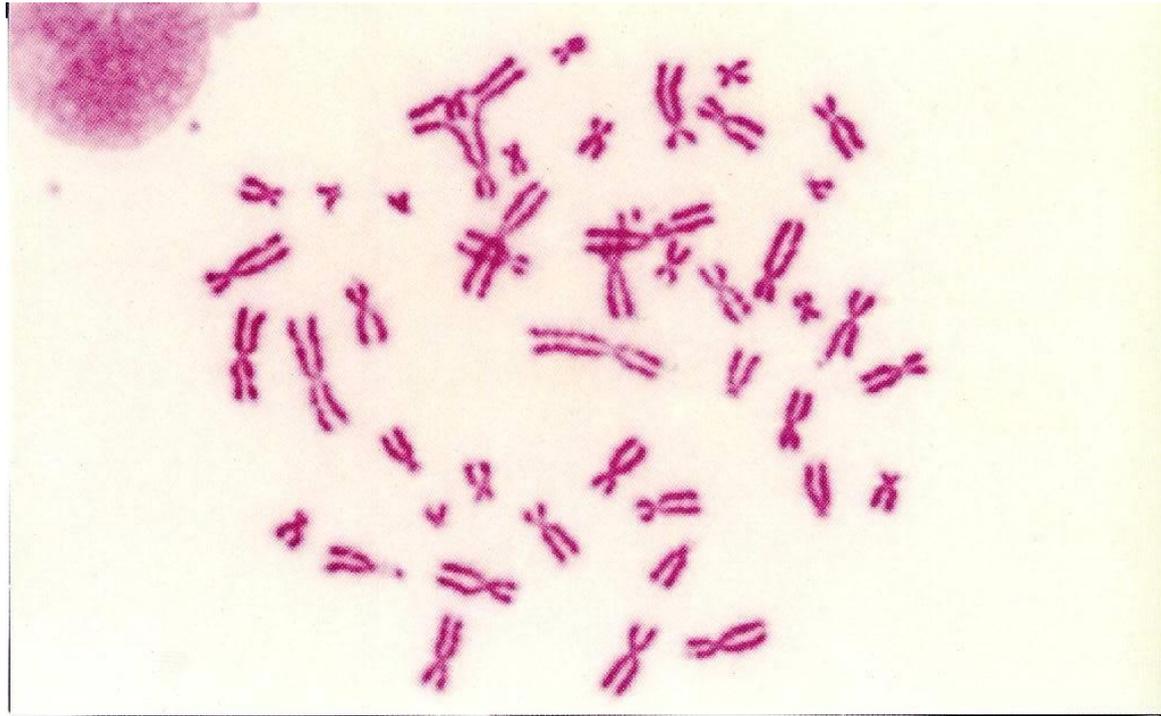


Karyotype



- The set of all chromosomes deriving from a cell's nucleus is called karyotype.

The number of the chromosomes is different in various species. For example humans have 46, dogs have 78, cats have 38.





The normal human karyotype

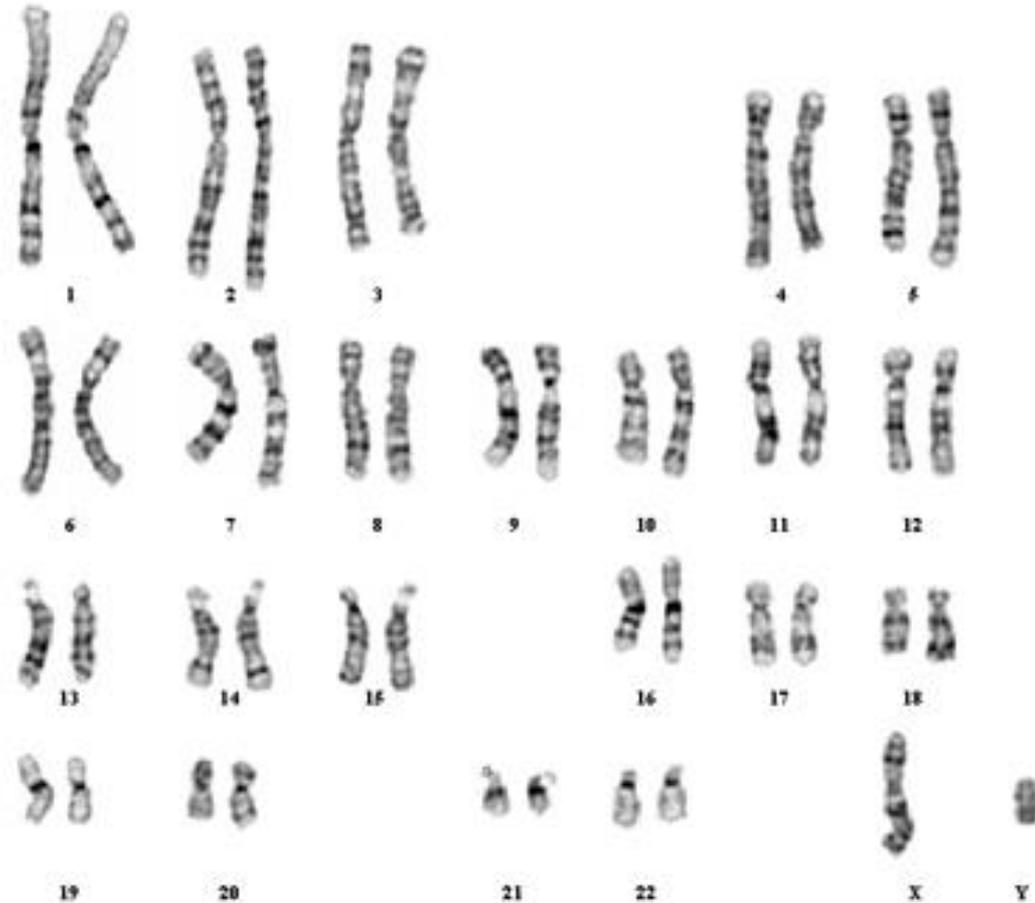
humans:

44 autosomes + 2
sex chromosomes

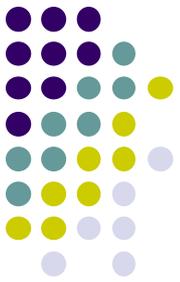
(altogether 23
pairs = 46 → 2n)

males: 44+XY or
46, XY

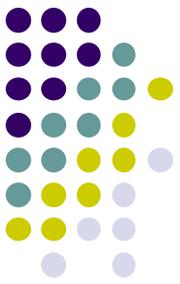
females: 44+XX
or 46, XX



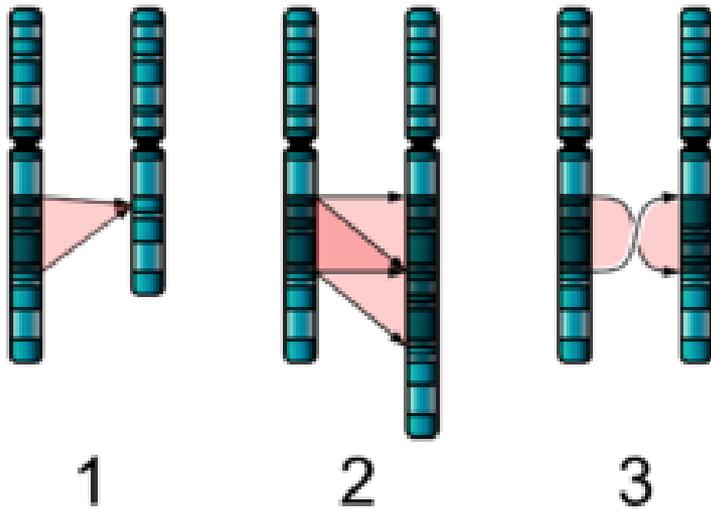
Diploid / haploid cells



- Sexually reproducing species have somatic cells (body cells), which are diploid [$2n$] having two sets of chromosomes, one from the mother and one from the father.
- Gametes, reproductive cells (egg, sperm), are haploid [n]: they have one set of chromosomes.
- Gametes are produced by meiosis of a diploid germ line cell.
- When a male and a female gamete merge (fertilization), a new diploid cell (fertilized egg) is formed. From this cell a new organism develops.



Structural chromosome abnormalities

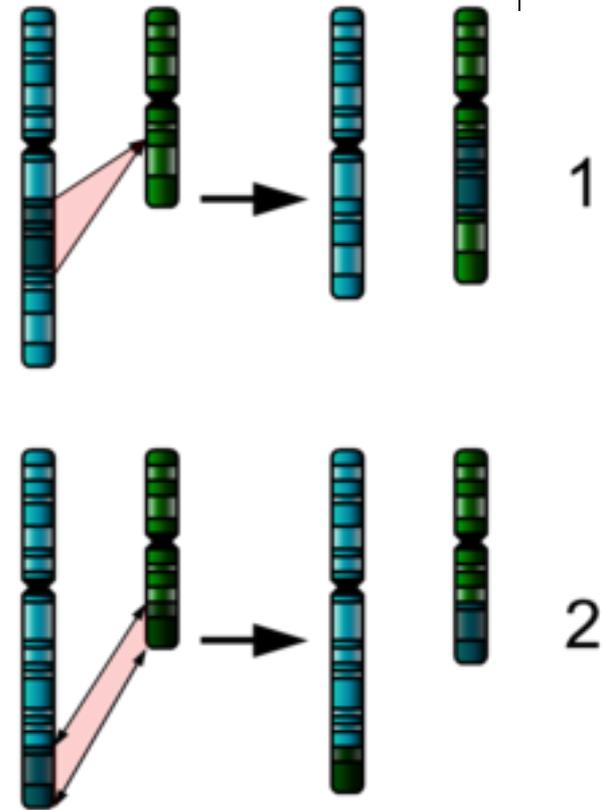


Single chromosome mutation

1) **Deletion** (e.g. Lejeune syndrome → cri du cat)

2) **Duplication**

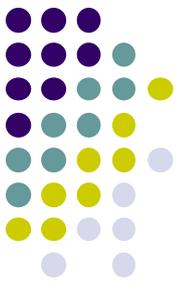
3) **Inversion**



Two-chromosome mutations

1) **Insertion**

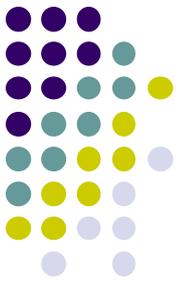
2) **Translocation**



Numerical chromosome abnormalities

- Polyploidy (e.g. triploidy, $3n$) → **lethal**
- Aneuploidy
 - Monosomy
 - Normally Y chromosome in males
 - Turner syndrome ($44 + X0$)
 - Trisomy
 - Down syndrome (trisomy 21)
 - Patau syndrome (trisomy 13)
 - Edwards syndrome (trisomy 18)

Down syndrome (trisomy 21)



FISH

