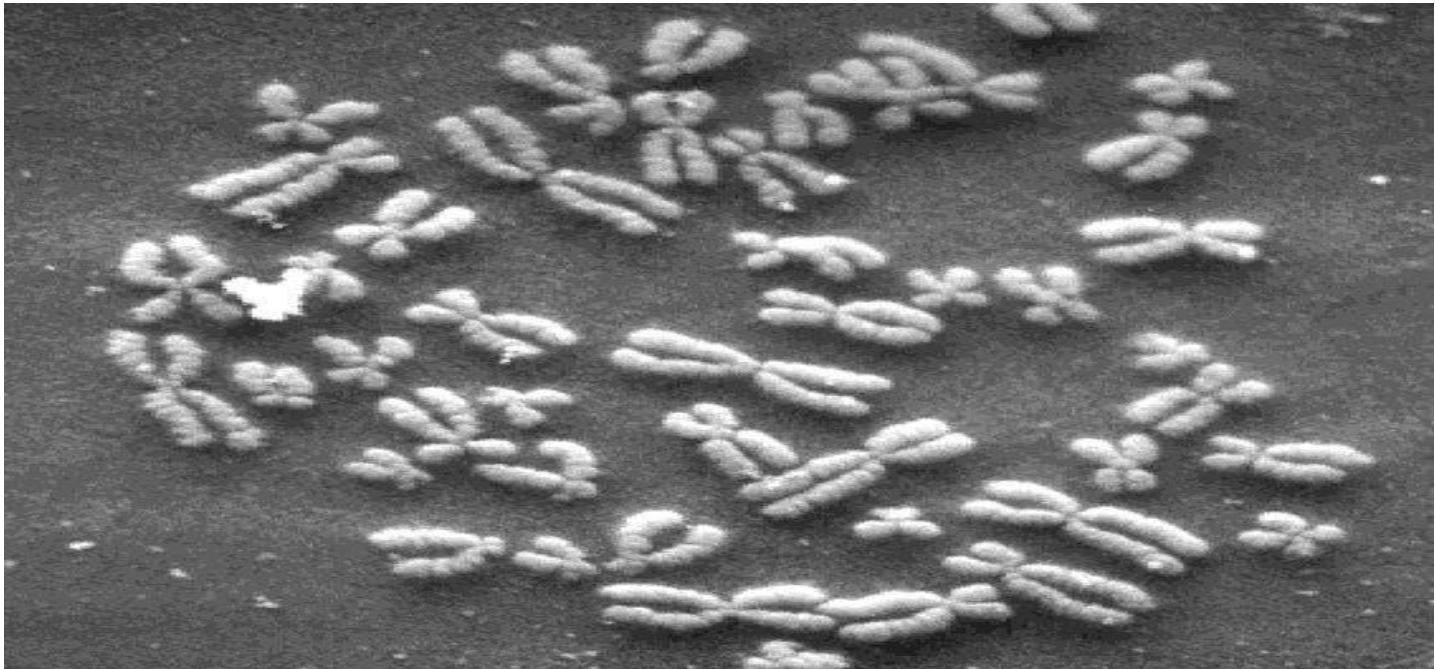


CHROMOSOMES



professor Dr. Mushtak T. S. Al-Ouqaili

Chromosomes in eukaryotes and prokaryotes are different

PROKARYOTES	EUKARYOTES
single chromosome plus plasmids	many chromosomes
circular chromosome	linear chromosomes
made only of DNA	made of chromatin, a nucleoprotein (DNA coiled around histone proteins)
found in cytoplasm	found in a nucleus
copies its chromosome and divides immediately afterwards	copies chromosomes, then the cell grows, then goes through mitosis to organise chromosomes in two equal groups

Chromosomes in eukaryotes

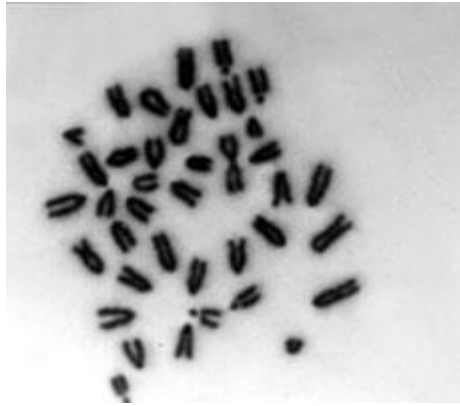


- Found in the nucleus
- Condensed and visible during cell division
- At the beginning of mitosis they can be seen to consist of two threads (sister chromatids) joined by a centromere
- The sister chromatids are identical copies
- During mitosis the sister chromatids separate and are placed into two nuclei

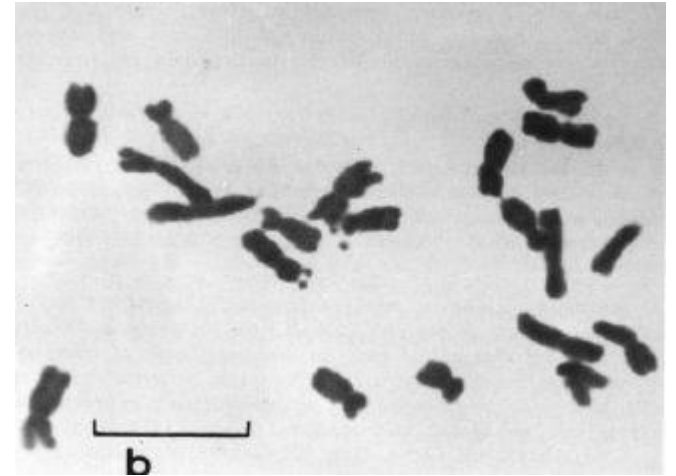


Numbers of chromosomes

- Constant for each cell in the body (except sex cells which only have half sets).
- Constant throughout the life of an individual (you don't lose or gain chromosomes)
- Constant for all members of a species



Mouse



Maize

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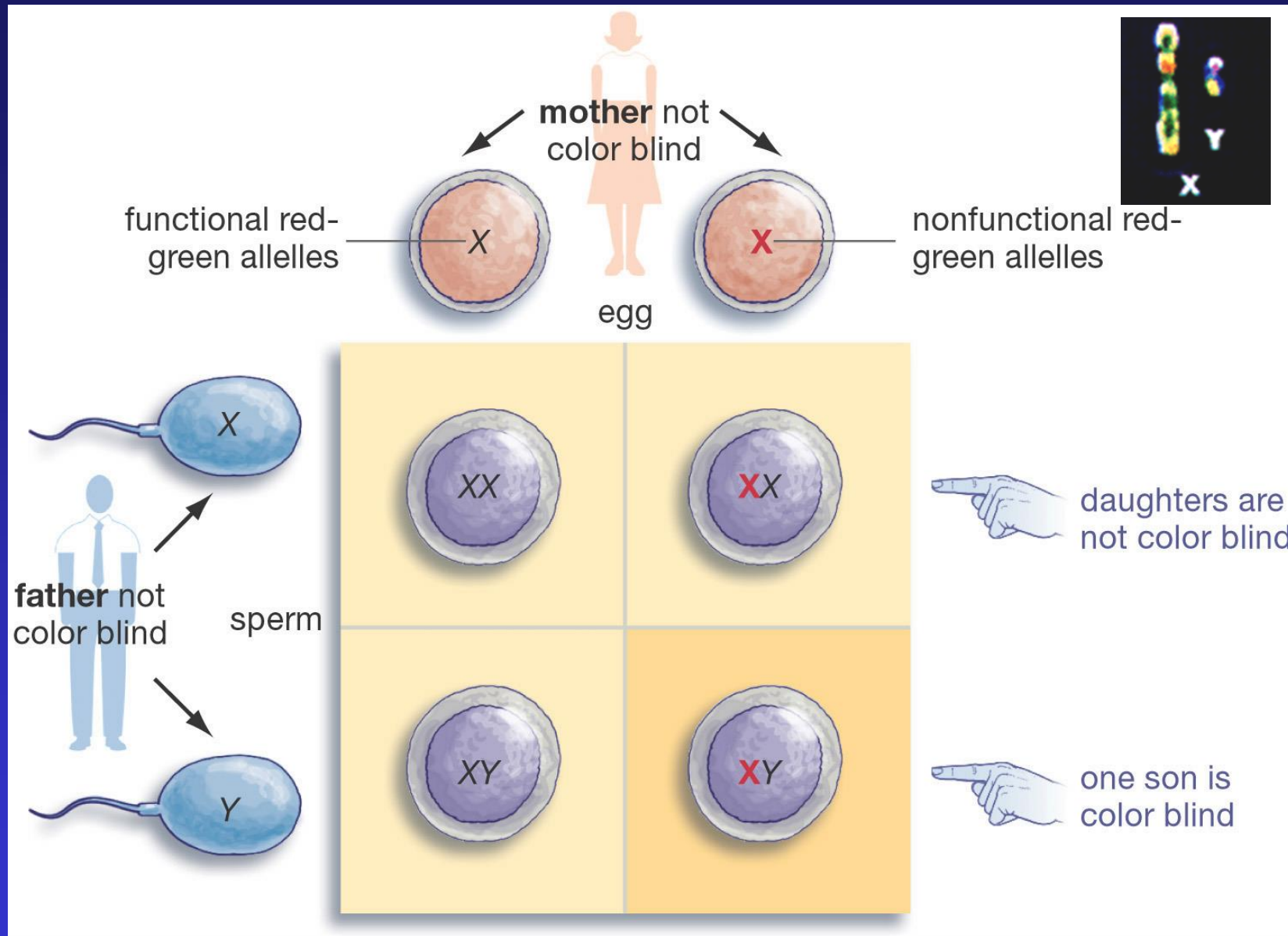
Chromosomes and Inheritance

Since genes are carried on chromosomes, knowledge of chromosome number and structure has far-reaching implications for basic genetics, human health, and evolution.



A normal human male karyotype.

X-linked Inheritance



There are many X-linked recessive traits.

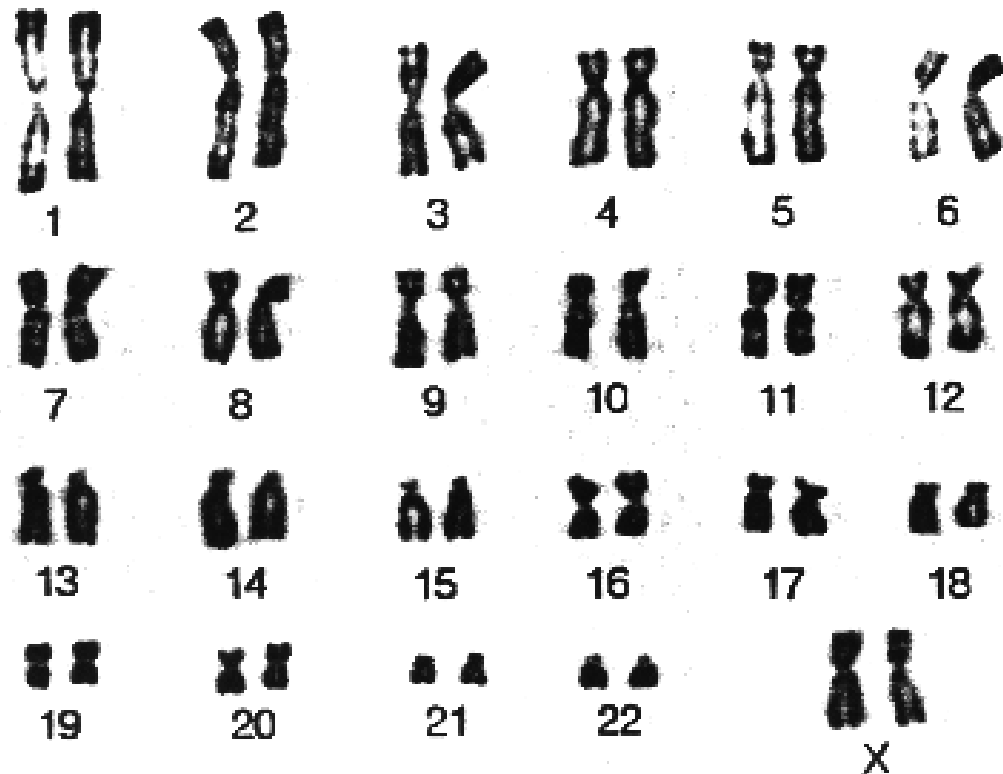
Organism	Chromosome numbers
Human	46
Chimpanzee	48
House Mouse	40
Maize	20

Human chromosomes



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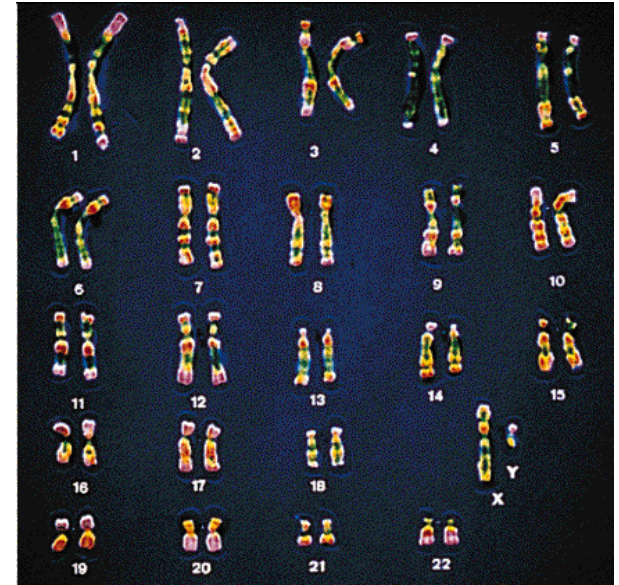
The chromosomes of a human female



Identifying chromosomes

Chromosomes can be identified by:

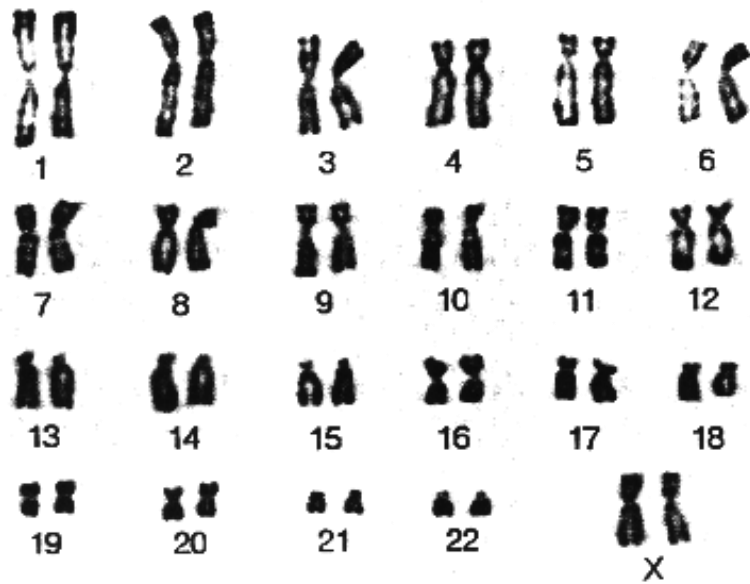
- Their size
- Their shape (the position of the centromere)
NB Chromosomes are flexible
- Banding patterns produced by specific stains (Giemsa)



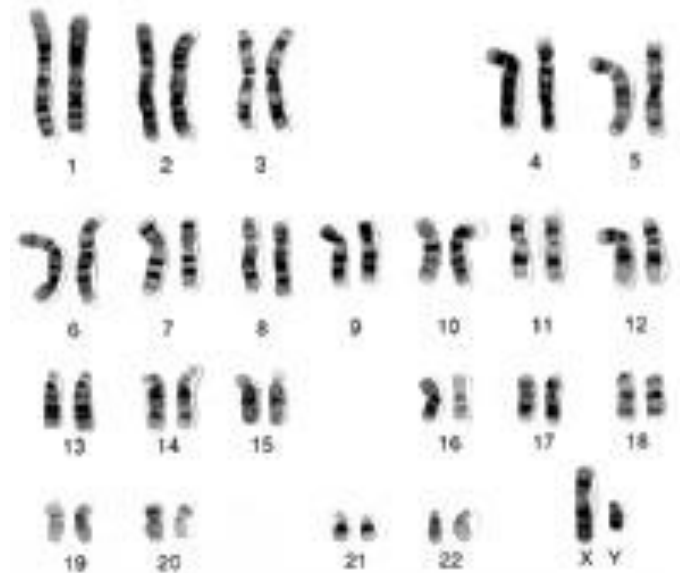
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Chromosomes are analysed by organising them into a

KARYOTYPE

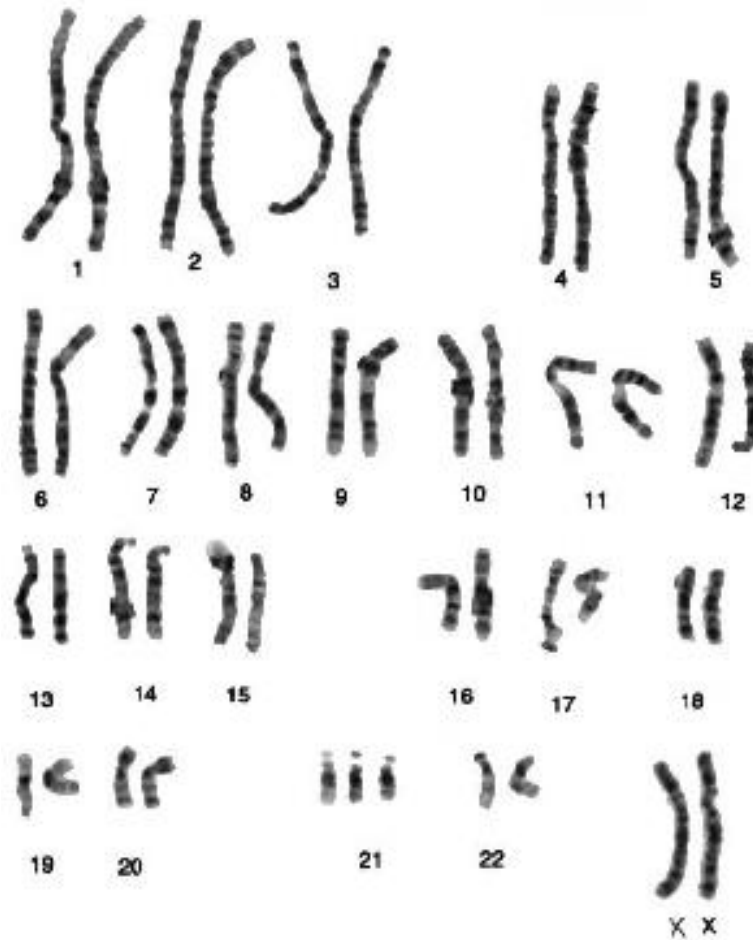


Female



Male

Down's syndrome



Changes in Chromosome Number and Structure

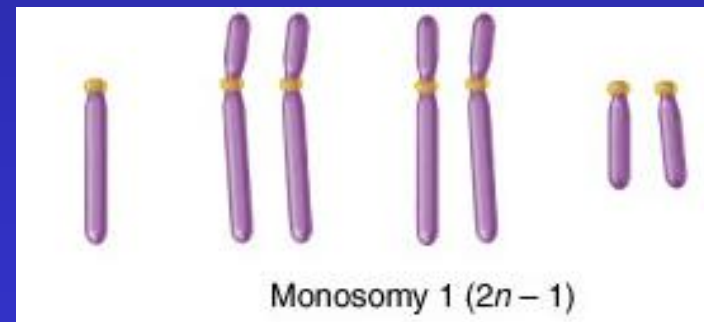
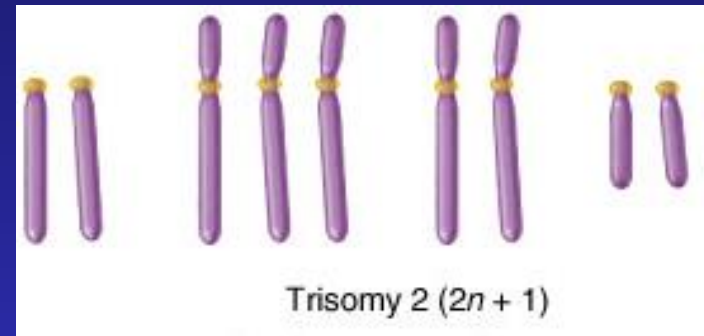
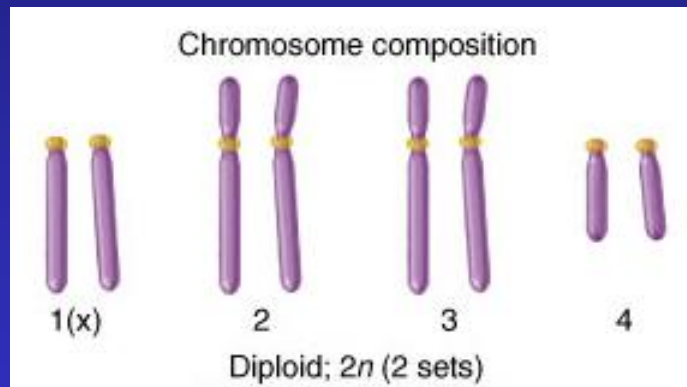
Changes in chromosome number and structure are important for health and evolution.



Down syndrome is caused by a change in chromosome number.

Aneuploidy

Aneuploidy occurs when one of the chromosomes is present in an abnormal number of copies.



Trisomy and monosomy are two forms of aneuploidy.

Down Syndrome is Caused by Trisomy for Chromosome 21

Aneuploidy is remarkably common, causing termination of at least 25% of human conceptions.

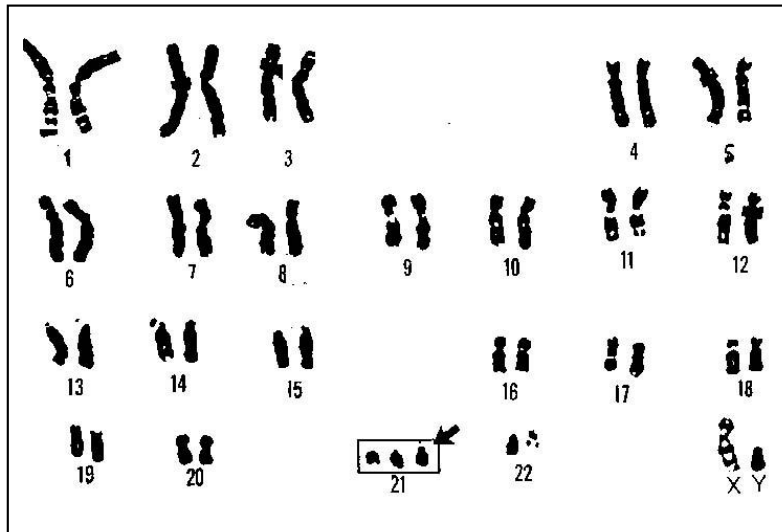
Aneuploidy is also a driving force in cancer progression (virtually all cancer cells are aneuploid).



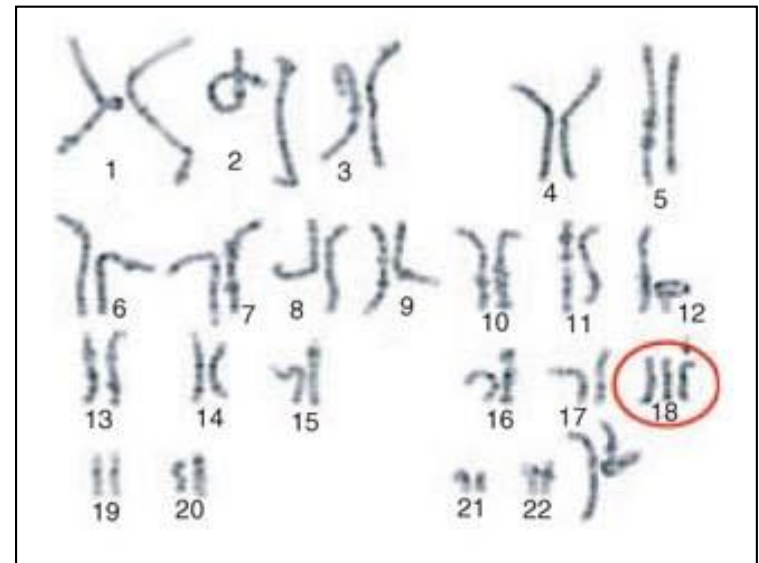
Development and chromosomes

- Differences in chromosomes are associated with difference in the way we grow.
- The karyotypes of males and females are not the same
Females have two large X chromosomes
Males have a large X and a small Y chromosome
The X and the Y chromosomes are called **sex chromosomes**
The sex chromosomes are placed at the end of the karyotype
- Unusual growth can be associated with **chromosome abnormalities**
e.g. People who develop Down's syndrome have trisomy 21

Chromosomal abnormalities

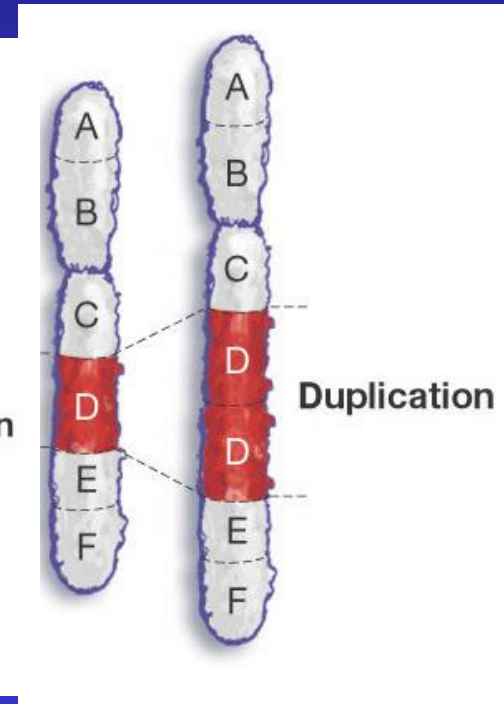
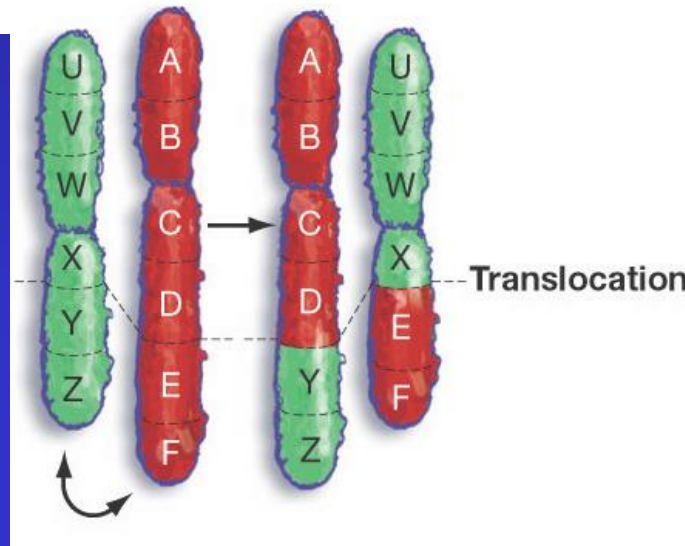
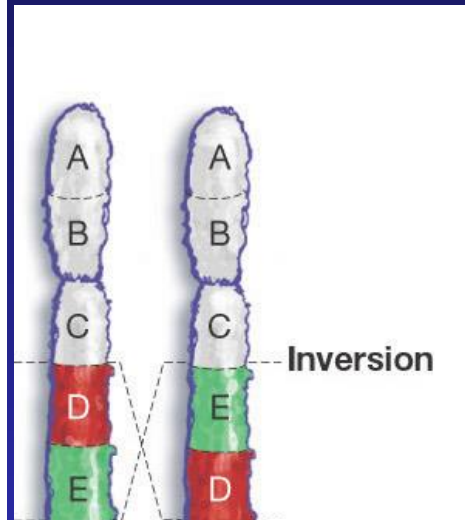
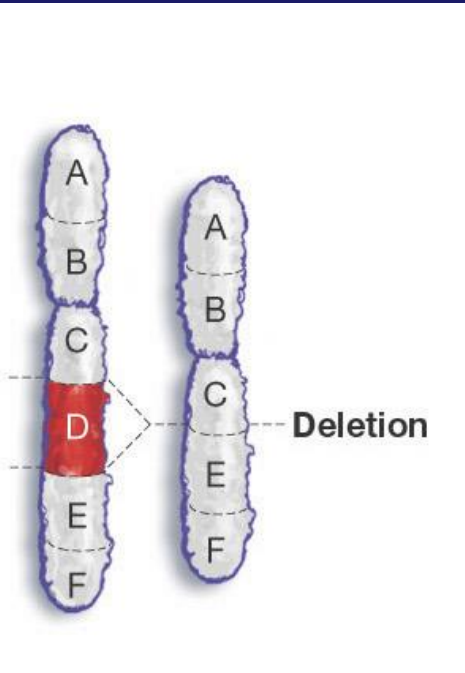


Trisomy-21 → Down's syndrome



Trisomy-18 → Edward's syndrome

Chromosome Structural Changes



There are 4 types of chromosome structural change – all of them associated with human disorders



**Therefore genetic information is
found on our chromosomes**

Chromosomes and cell division

- Multicellular organisms **copy** their chromosomes before cell division.
- They must **grow** to a mature size.
- The nucleus divides, distributing the chromosomes into two equal groups (**mitosis**).
- The cytoplasm then divides (**cytokinesis**) each part taking a nucleus.

} **Interphase**

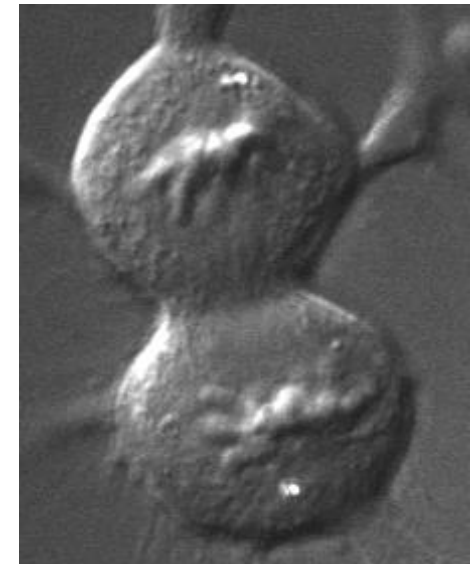
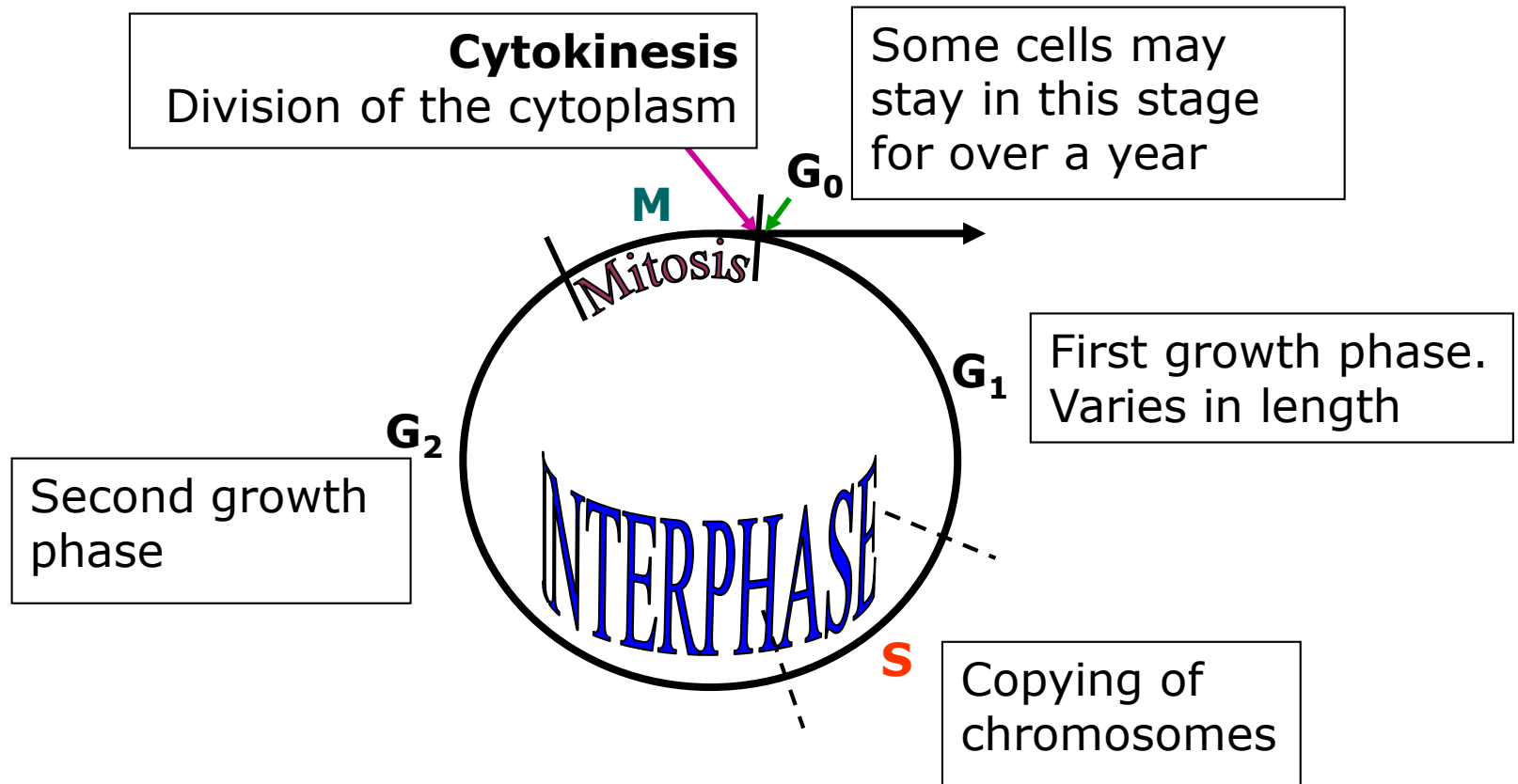


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The cell cycle



$$G_1 + S + G_2 = \text{INTERPHASE}$$

The cell cycles in different cells

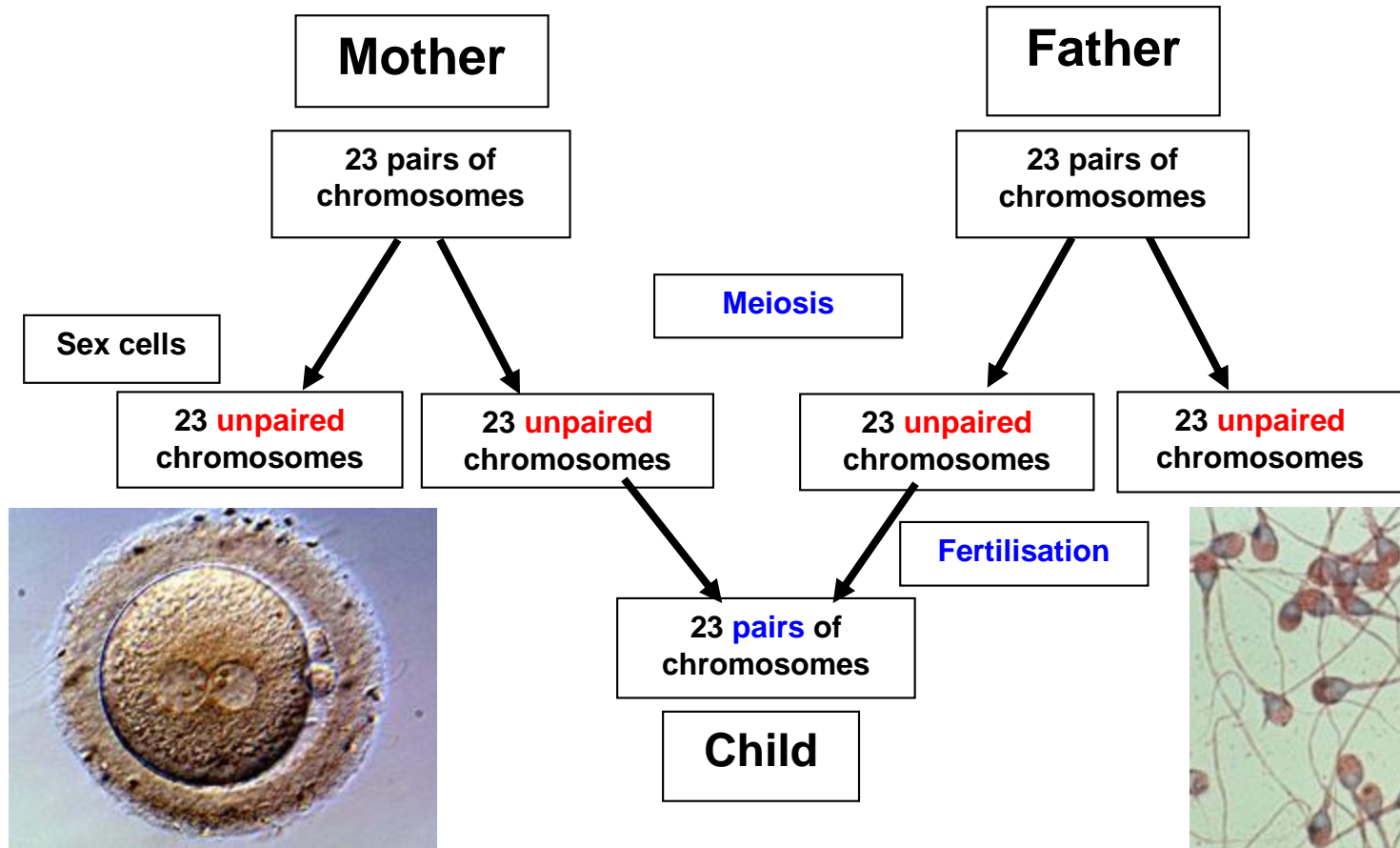
Cell type	Cell cycle / hours
Bean root tip	19.3
Mouse fibroblast	22
Chinese hamster fibroblast	11
Mouse small intestine epithelium	17
Mouse oesophagus epithelium	181



Chromosomes and reproduction

- Chromosomes come in pairs
One of the pair is maternal the other is paternal
- When parents make sex cells the number of chromosomes must be halved
One of each type of chromosome is taken

Meiosis and fertilisation





Meiosis

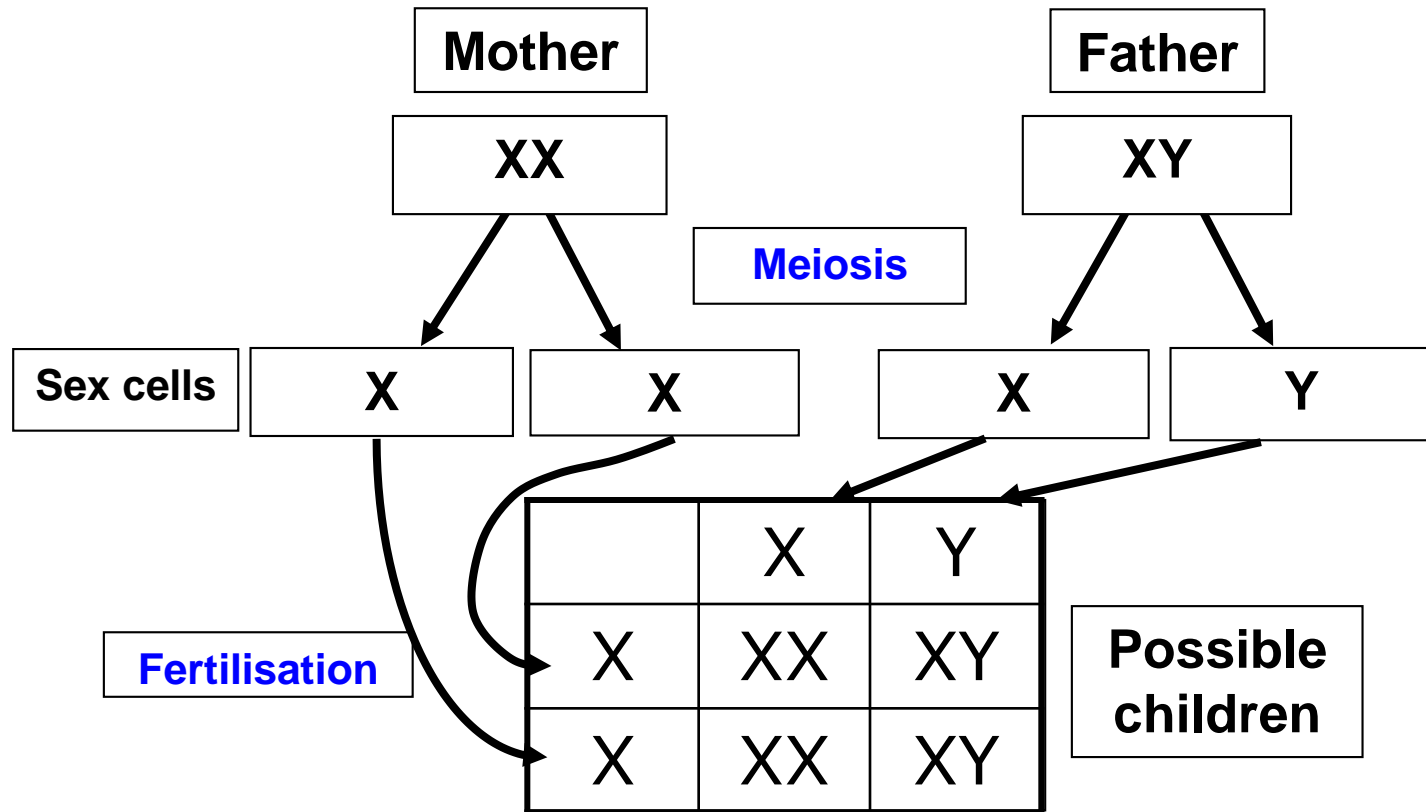
- A special type of cell division
- Used to make **sex cells**
- Meiosis **halves** the numbers of chromosomes
- Meiosis picks one chromosome from each pair at random and places them in a sex cell. This results in enormous variation amongst the sex cells.

The inheritance of gender

Is it going to be a boy or a girl?



The inheritance of gender



Chance of a girl 50%
Chance of a boy 50%



Sex chromosomes

- The sex of many animals is determined by genes but on chromosomes called **sex chromosomes**
- The other chromosomes are called **autosomes**
- One sex is homogametic
- The other sex is heterogametic

Sex determination in different animals

HOMOGAMETIC SEX	HETEROGAMETIC SEX	SEX DETERMINATION
Female XX	Male XY	Presence of Y- chromosome = maleness (mammals and fish) Presence of second X- chromosome = femaleness (Drosophila, the fruit fly)
Male ZZ	Female ZW	Birds, amphibians, reptiles, butterflies, moths.
Female XX	Male Xo	Grasshoppers