

CHROMOSOMES



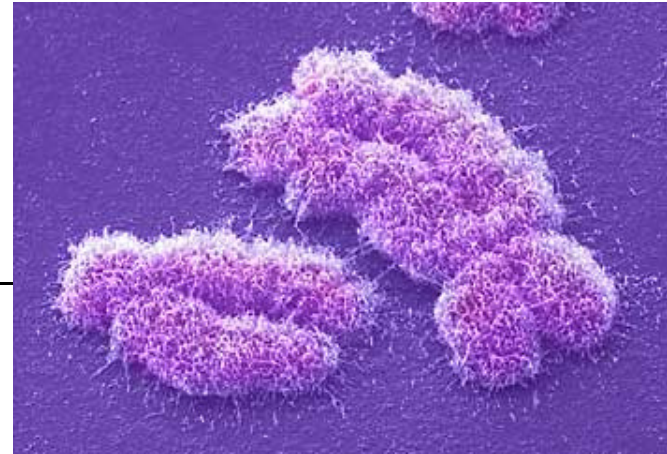
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Chromosomes in eukaryotes and prokaryotes are different

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

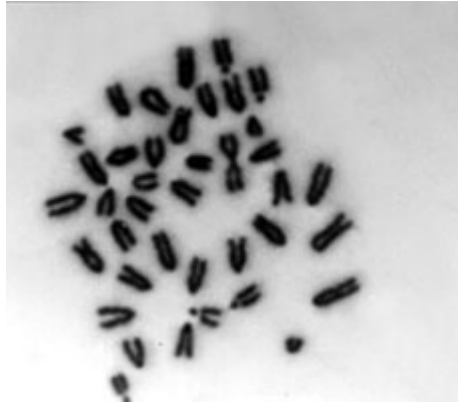


- Found in the nucleus
- Condensed and visible during cell division
- At the beginning of mitosis they can be seen to consist of two threads (sister chromatids) joined by a centromere
- The sister chromatids are identical copies
- During mitosis the sister chromatids separate and are placed into two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



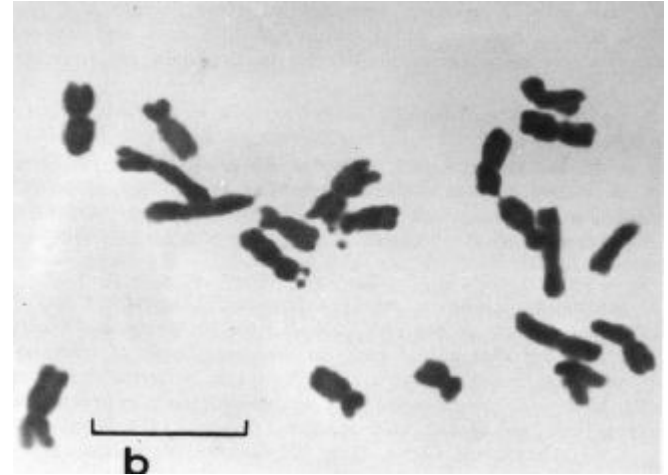
Numbers of chromosomes

- 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

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Maize

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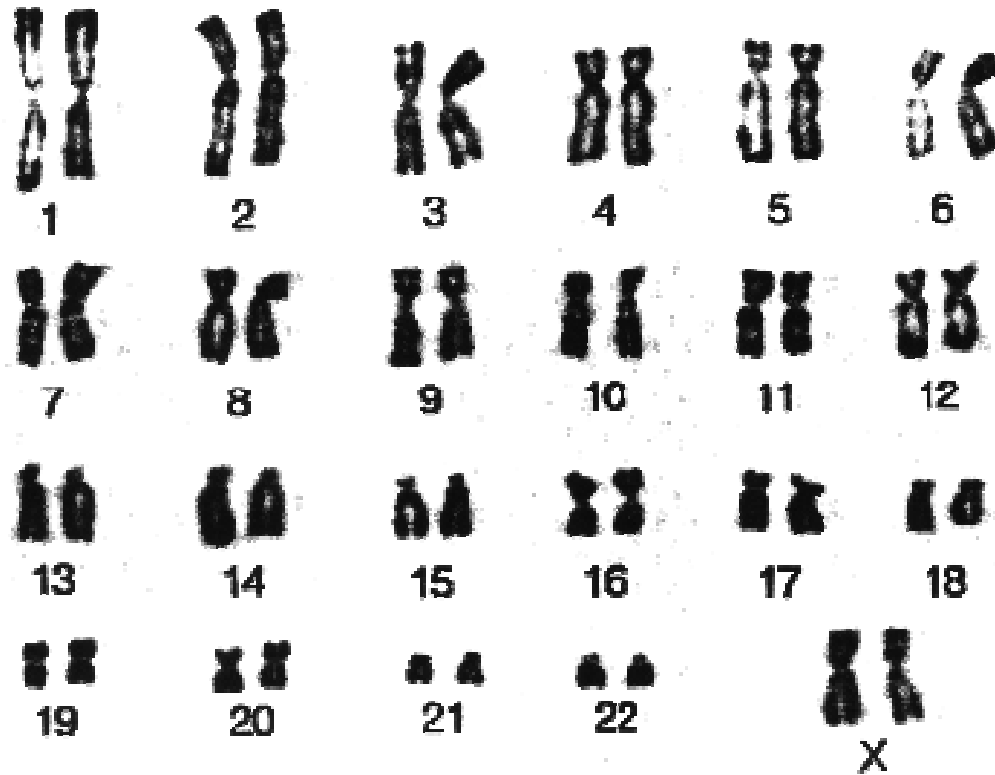
Organism	Chromosome numbers
Human	46
Chimpanzee	48
House Mouse	40
Maize	20

Human chromosomes



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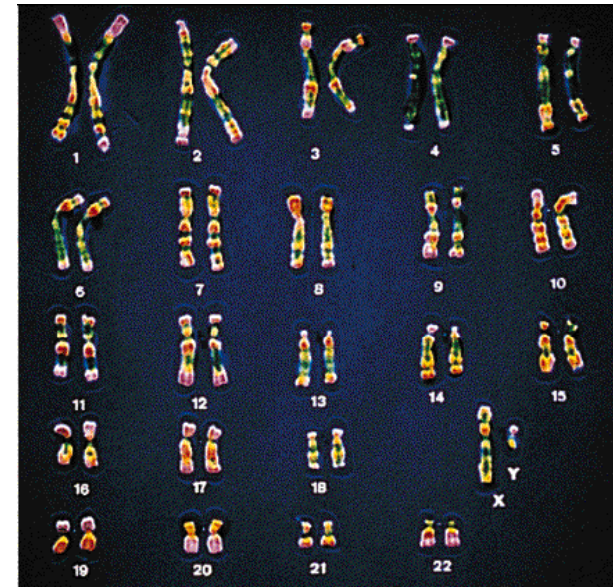
The chromosomes of a human female



Identifying chromosomes

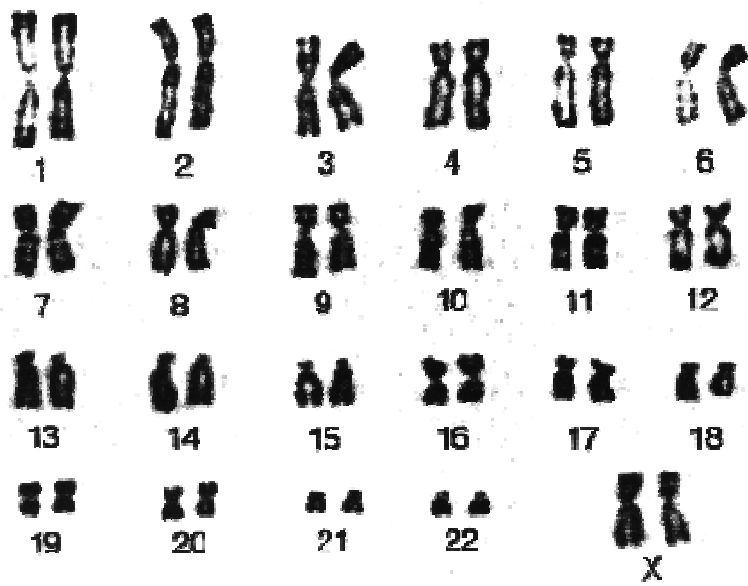
Chromosomes can be identified by:

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

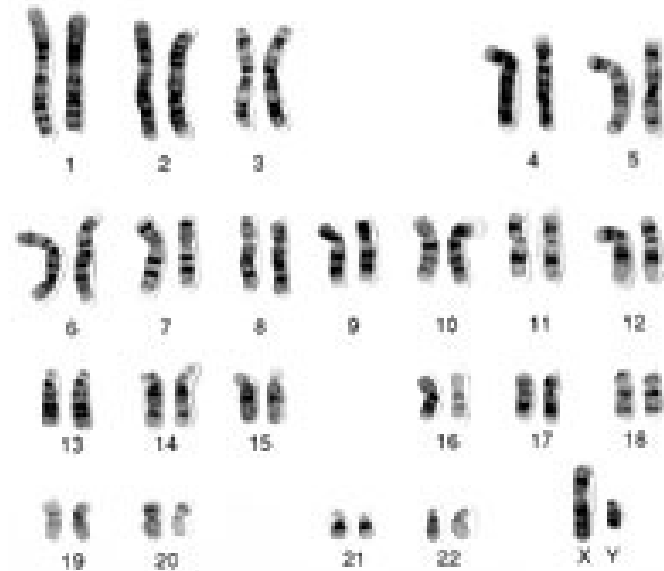


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Chromosomes are analysed by organising them into a **KARYOTYPE**



Female



Male

Down's syndrome

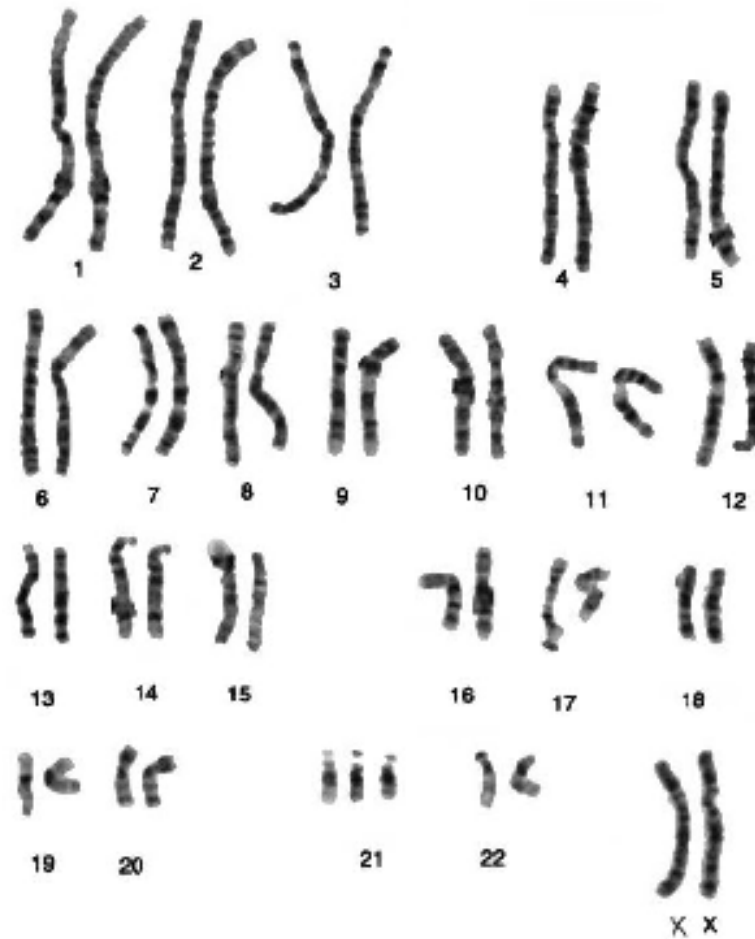


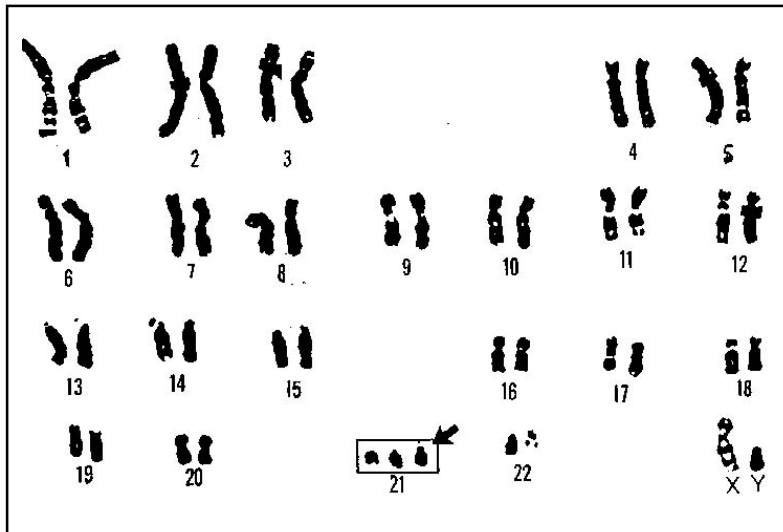
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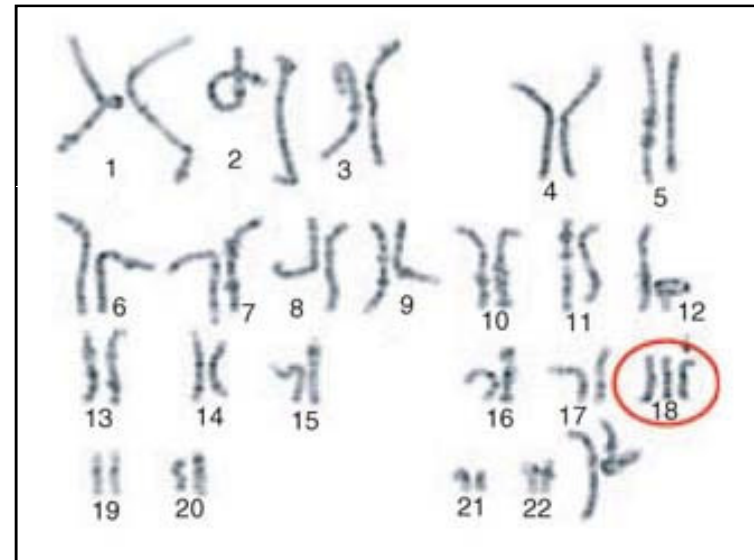
Development and chromosomes

- 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



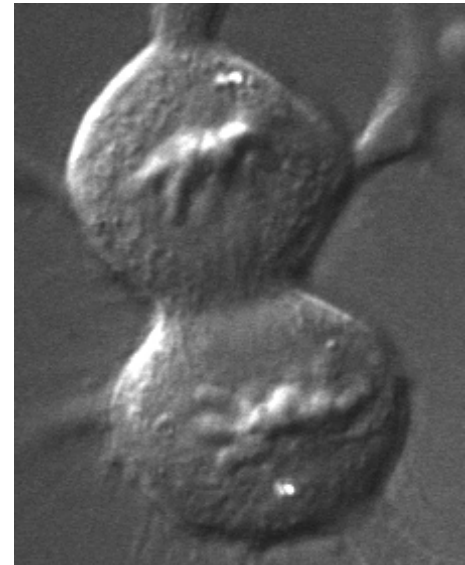
Trisomy-18 → Edward's syndrome



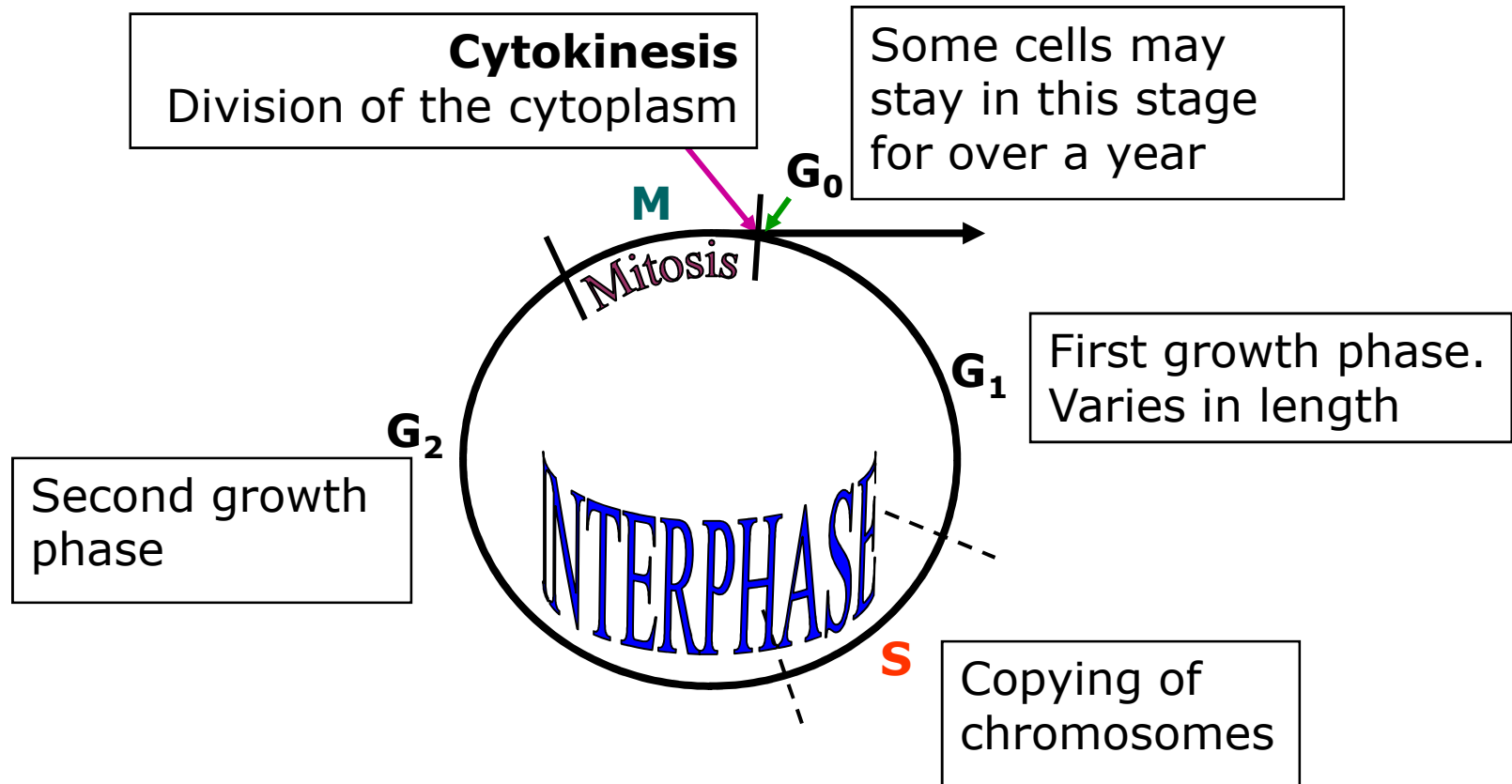
**Therefore genetic information is
found on our chromosomes**

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**



The cell cycle



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



The cell cycles in different cells

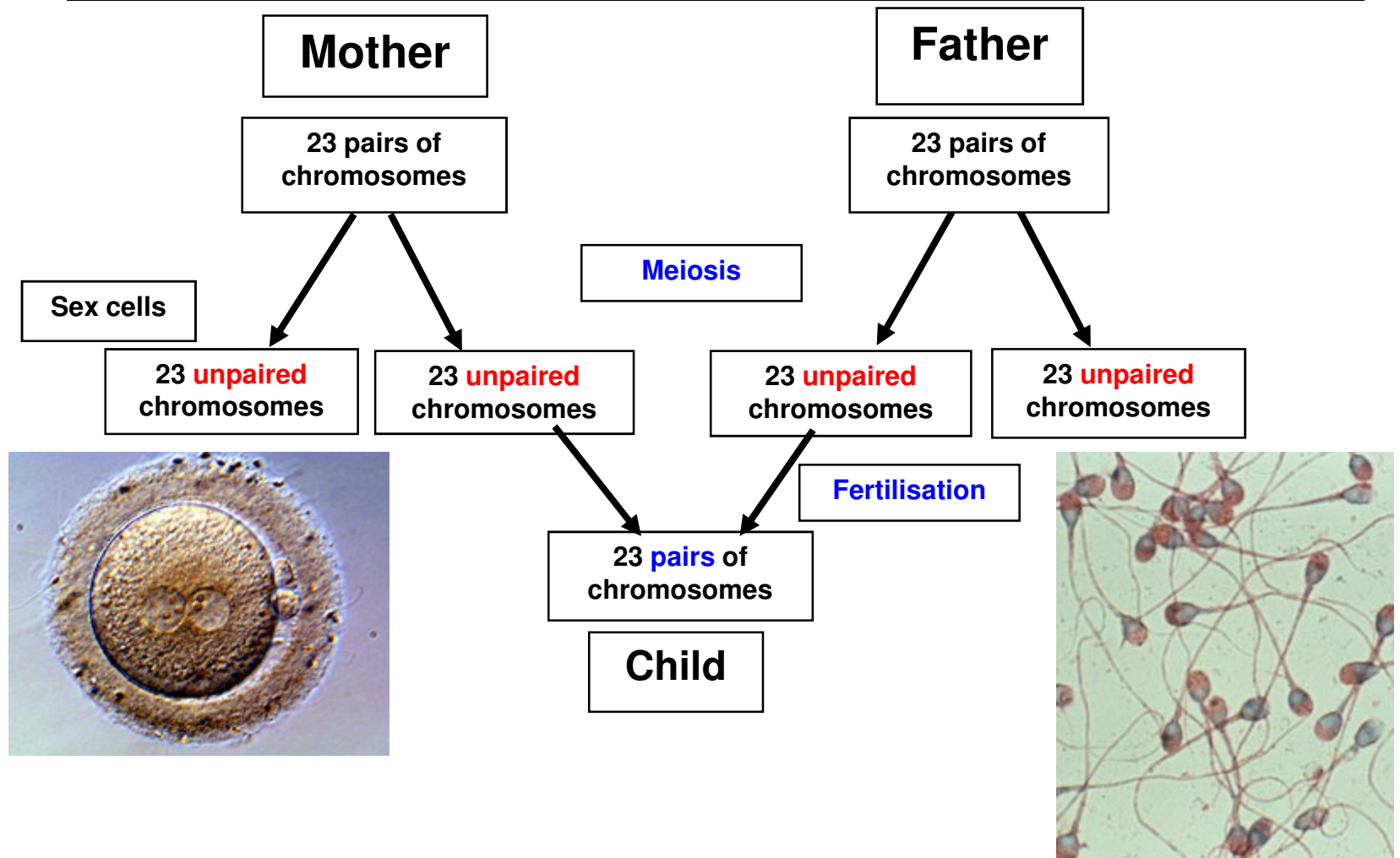
Cell type	Cell cycle / hours
Bean root tip	19.3
Mouse fibroblast	22
Chinese hamster fibroblast	11
Mouse small intestine epithelium	17
Mouse oesophagus epithelium	181



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.

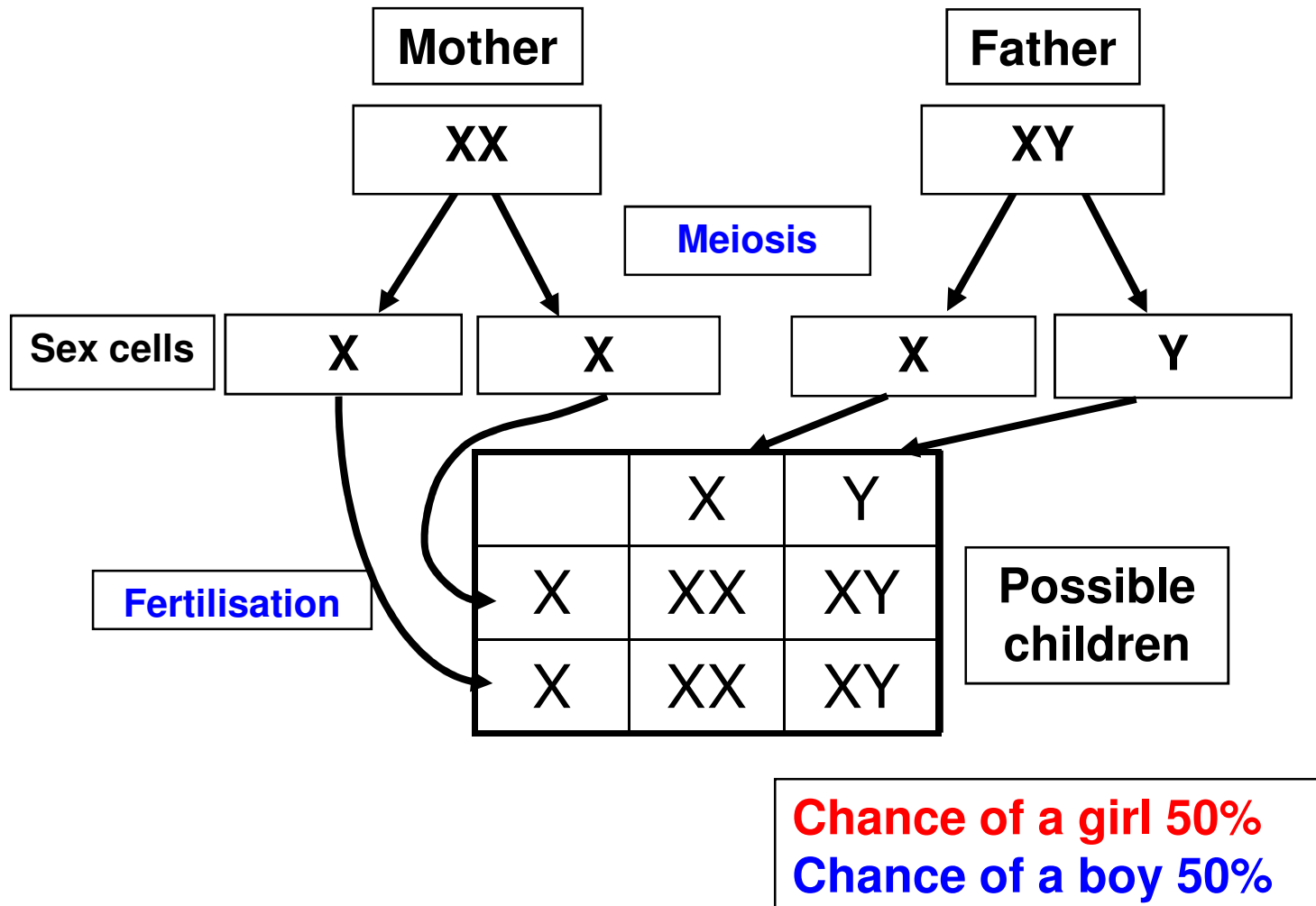
The inheritance of gender

Is it going to be a boy or a girl?



© University of New Mexico

The inheritance of gender





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