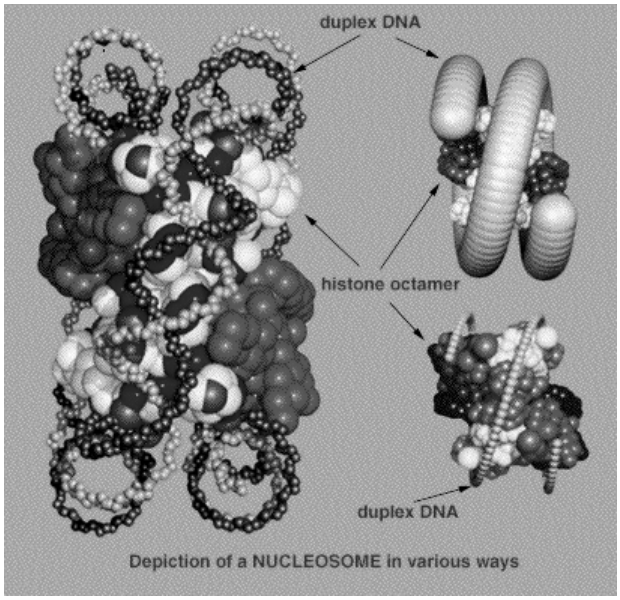
Nucleosome



The Cell Division Cycle

- Almost **90%** of the cycle is taken up with **Interphase** during which DNA in the nucleus is replicated
- **Mitosis** and **cytokinesis** only take up 10% of the cycle

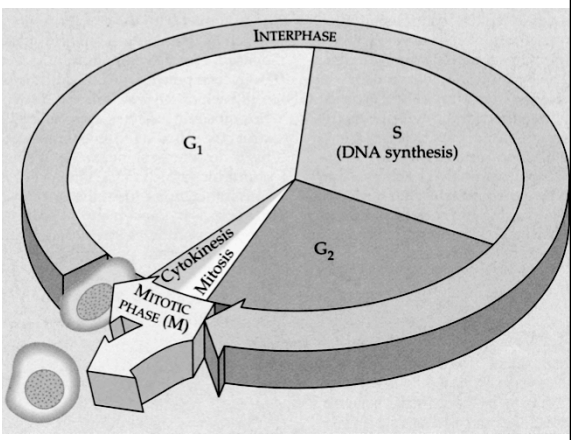
Trillions of cells in human body.

At least 5 trillion cell divisions required from fertilised egg → adult human.

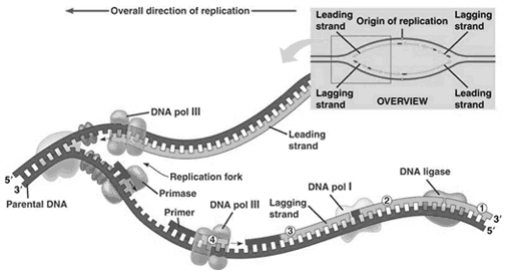
Copy of 3 x 10^9 bases of DNA required for each daughter cell – each copy must be accurate.

Mistakes can lead to disease.

Replication machinery enormous - approx. 200 proteins involved in replicating the genome.

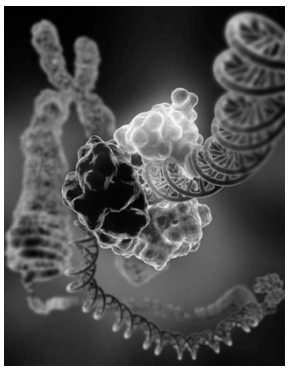


http://cellnews-blog.blogspot.com/2010/04/movies-for-human-genome.html



It is believed that somewhere between 1,000 – 1,000,000 molecular lesions occur per cell per day. Efficient repair systems are essential!

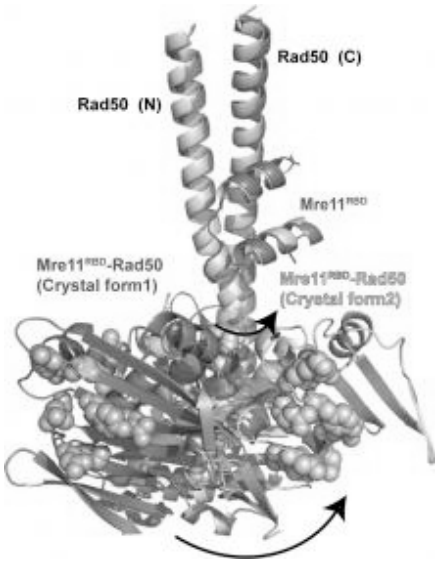
Some of the machinery involved in DNA replication & editing



DNA ligase, an enzyme, encircles the DNA helix and repairs a broken strand of DNA
(http://en.wikipedia.org/wiki/File:DNA_Repair.jpg

Rad50, a protein involved in checking & repairing DNA. There are many different proteins involved in these processes.

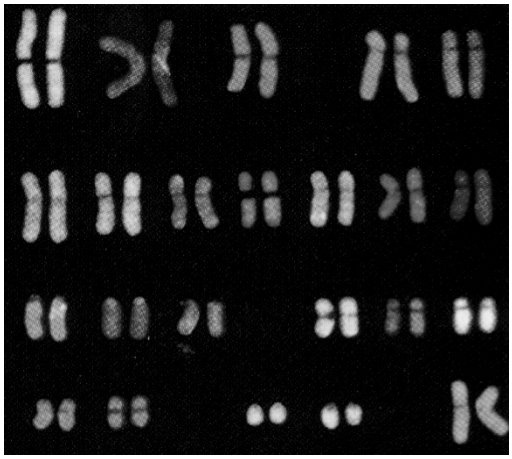
Ineffective DNA repair can lead to a cell which does not function well or to a cell, for example, that has an increased risk of tumour formation



www.physorg.com/news/2011-03-dna-complex-reveals-powerful-cell.html

Human metaphase chromosome spread

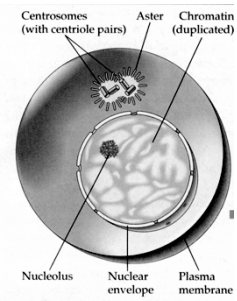
Chromosomes arranged in pairs



MITOSIS

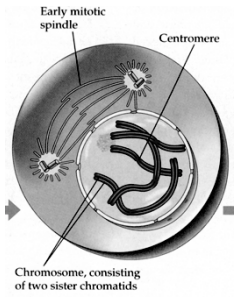
- A multicellular organism **grows** by **repeated cell divisions**
- These occur using the process of **mitosis**
- Each cell receives an **identical set of chromosomes**
- Almost any change in chromosome number is **lethal**
  There are a few exceptions, one is Down's syndrome where individuals have an extra **chromosome 21**
- In humans, each cell contains **23 pairs** of chromosomes
  23 paternal chromosomes
  23 maternal chromosomes
  46

MITOSIS



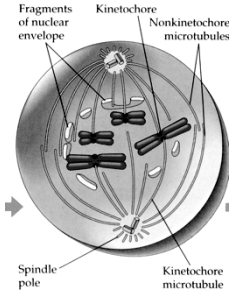
Interphase

•DNA has been replicated but
•**Chromosomes** not yet visible



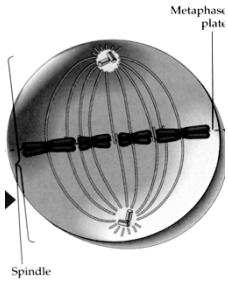
Prophase

•Chromosomes condense and thicken
•Each duplicated chromosome appear as two identical sister **chromatids**
•The **mitotic spindle** begins to form



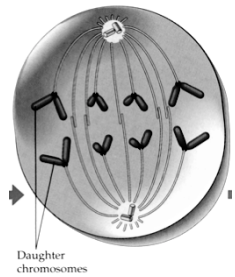
Prometaphase

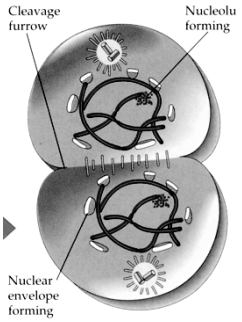
•The nuclear envelope fragments
•The **spindle fibres** become attached to the centre of each chromosome = **kinetochore**



Metaphase

•The chromosomes assemble at the equator = **metaphase plate**



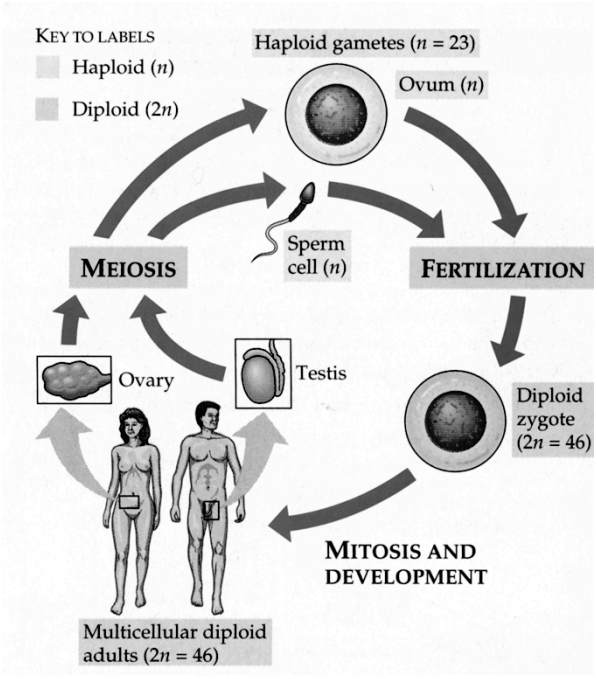


Anaphase

- The **spindle fibres** begin to contract
- This starts to pull the **sister chromatids** apart
- At the end of anaphase a complete set of **daughter chromosomes** is found each pole

Telophase and Cytokinesis

- **Nuclear envelopes** begin to form around each set of daughter chromosomes
- A cleavage furrow divides the cytoplasm in two = **cytokinesis**



- **Mitosis cannot be the only type of cell division!**

- **If it were**, the chromosome number **would double** in **each** generation

Parents **46** + **46**

↓

F1 Offspring **92**

Next generation 92 + 92

↓

184

Remember changes in chromosome number are **usually lethal** !

The solution: a **reduction division** called **meiosis** that **halves** the **number of chromosomes** in **gametes** (i.e. in sperm and eggs)

Female (46) **Male (46)** **(Diploid)**

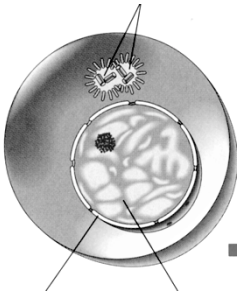
↓ ← **meiosis** → ↓

egg (23) + **sperm (23)** **(Haploid)**

↓

46 **(Diploid)**

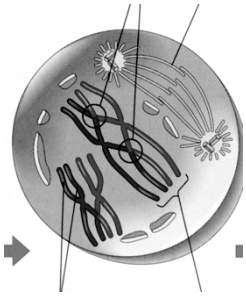
MEIOSIS I



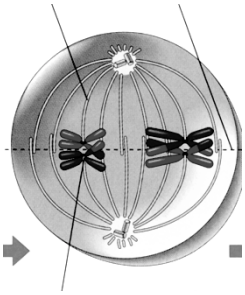
Interphase I

- Each chromosome replicates
- The result is two genetically identical **sister chromatids**

Prophase I (Crossing-over → recombination)

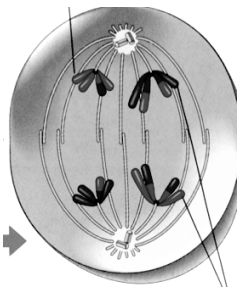


- **Homologous** chromosomes (each consisting of two sister chromatids) come together as pairs
- The structure formed is called a **tetrad**
- Chromosome segments are swapped between non-sister chromatids at cross-over points called **chiasmata** (= **crossing-over**)



Metaphase I

- Chromosomes align on the **metaphase plate**
- Chromosomes still arranged as: **pairs of homologues**

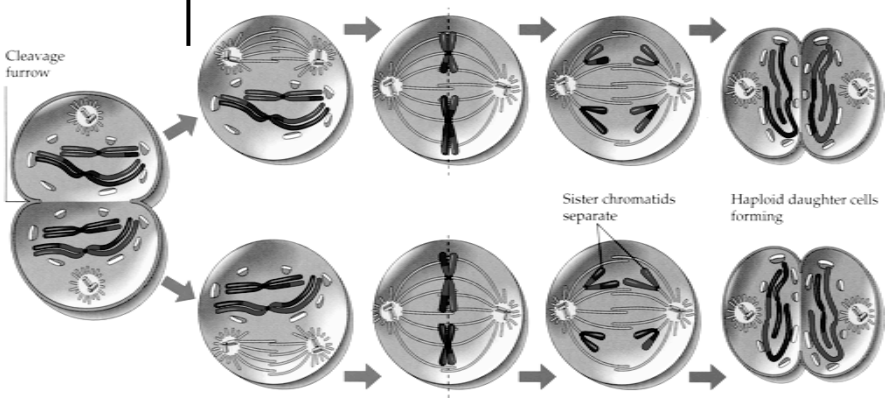


Anaphase I

- Sister chromatids **remain attached**
- But **homologous chromosomes move apart to opposite poles**

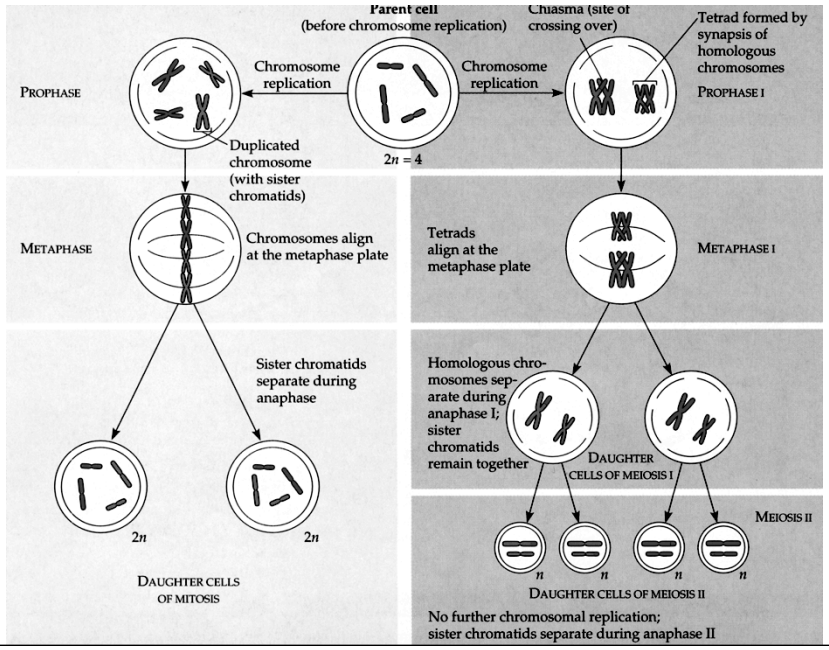
MEIOSIS I | **MEIOSIS II – separation of sister chromatids**

Telophase I | Prophase II | Metaphase II | Anaphase II | Telophase II

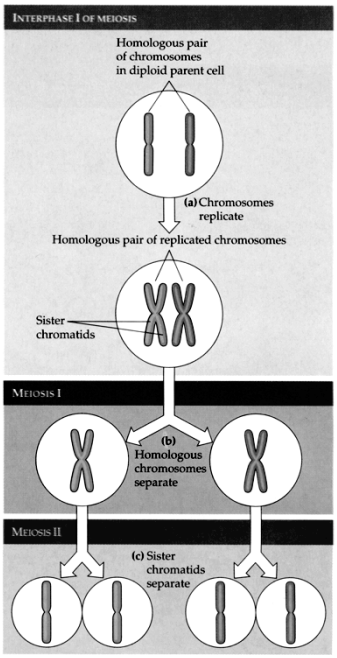


4 haploid cells

MITOSIS | **MEIOSIS**



Meiosis: how the chromosome set is halved



A diploid cell

One pair of homologous chromosomes

Replication of each chromosome
two sister chromatids

Meiosis I

Each cell receives **only one** of the homologues

Meiosis II

Each cell receives **only one** sister chromatid

The consequences of crossing over: recombination