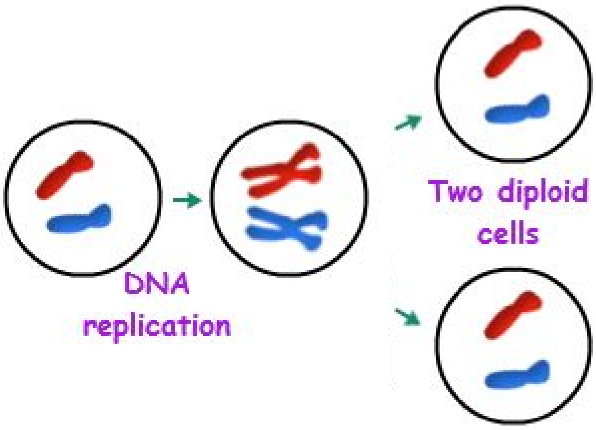
Mitosis

Used for: growth and repair



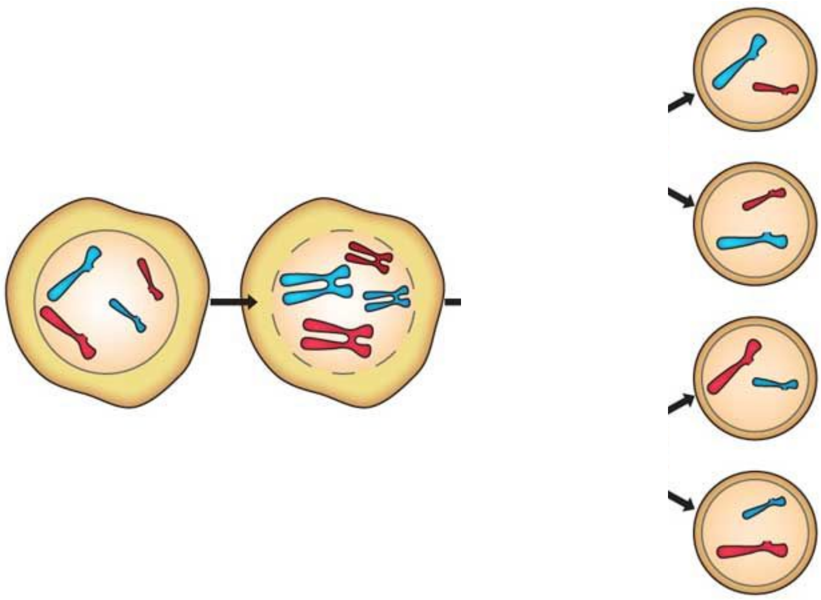
A method of cell division, where:

- One parent cell divides into two daughter cells
- Each daughter cell has the full complement of genes (diploid)
- Each daughter cell is genetically identical to the parent cell (all alleles are identical)

(Fungi and plants can use mitosis for asexual reproduction)

Meiosis

Used for: producing gametes (egg and sperm cells)
Creating variety in the population

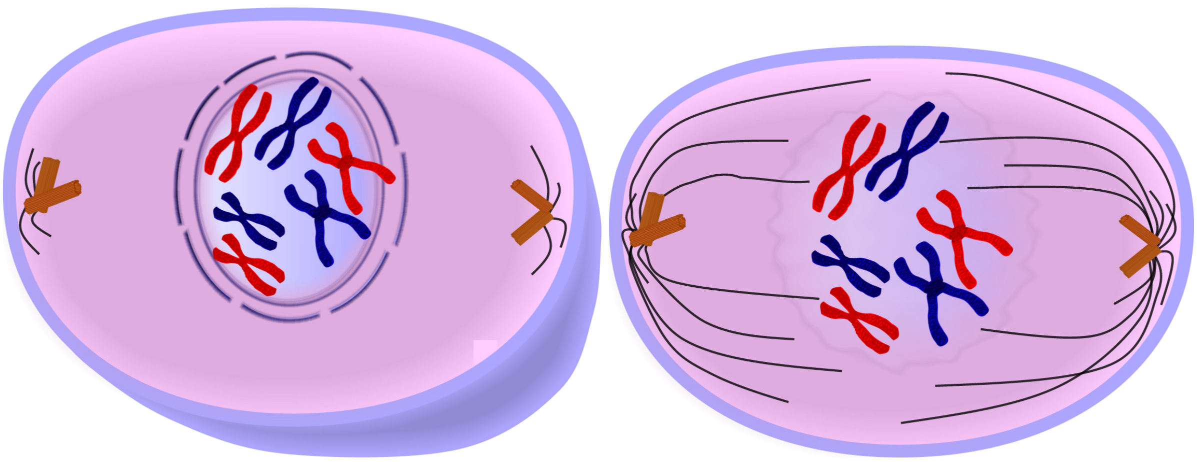


A method of cell division, where:

- One parent cell (diploid = 2n) divides into four daughter cells
- Each daughter cells gets only half the number of chromosomes of the parent (haploid = n)
- Daughter cells are genetically different from parents (only half the alleles inherited)

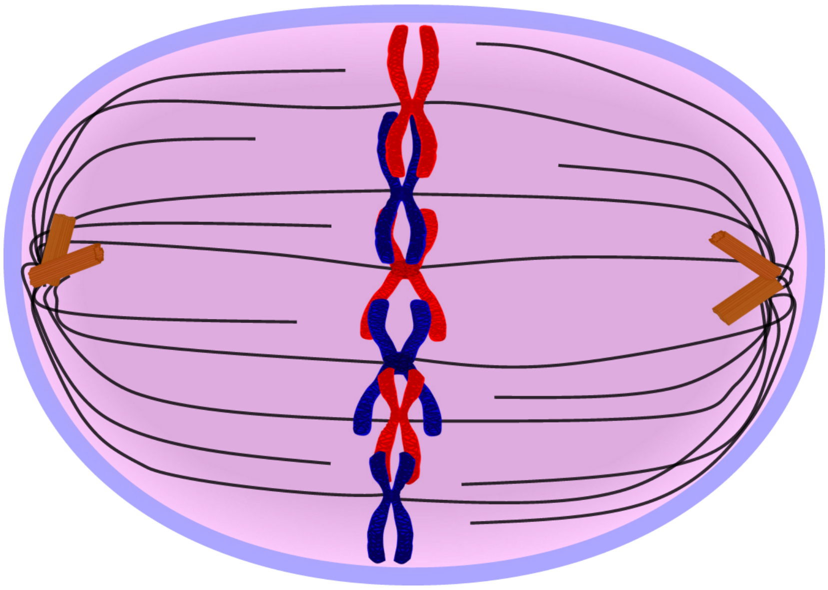
Steps in Mitosis (pg 77)

Prophase



- Nuclear envelope starts to break down
- Chromosomes condense and become visible
- Centrioles move to opposite poles of the cell
- Long protein fibers called microtubules extend from the centrioles in all possible directions, forming what is called a spindle (spindle apparatus)

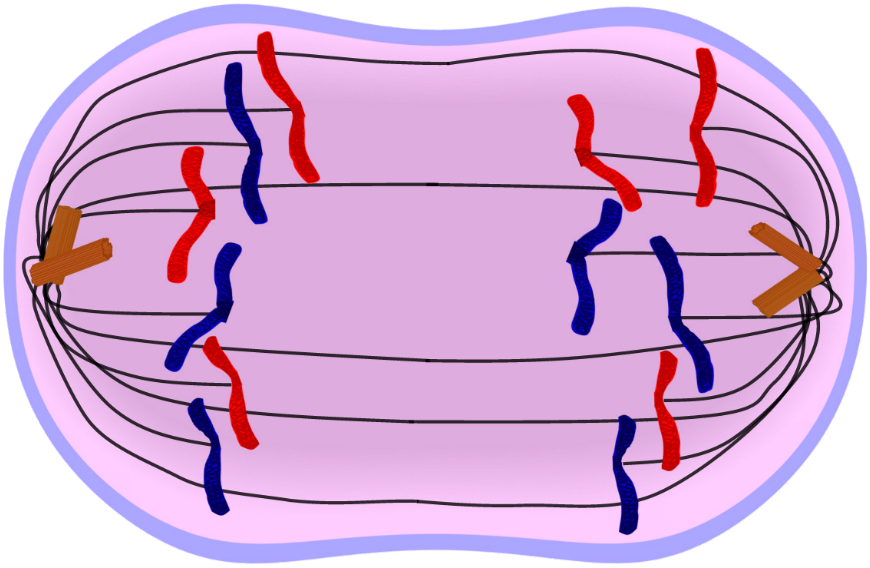
Metaphase



- Microtubules of the spindle attach the centromere of each chromosome, to the centrioles at the poles
- This ensures that chromosomes (sister chromatids) line up along the equator

(This is an important checkpoint in the cell cycle - to ensure that all of the chromosomes are attached to the spindle and ready to be divided)

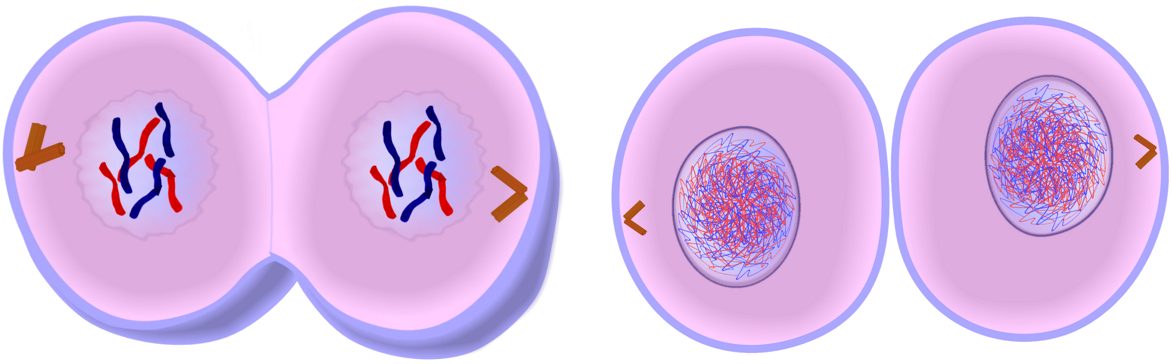
Anaphase



- Centromere divides into two
- Spindle fibres contract
- Each sister chromatid is pulled to the opposite pole of the cell
- This process requires ATP

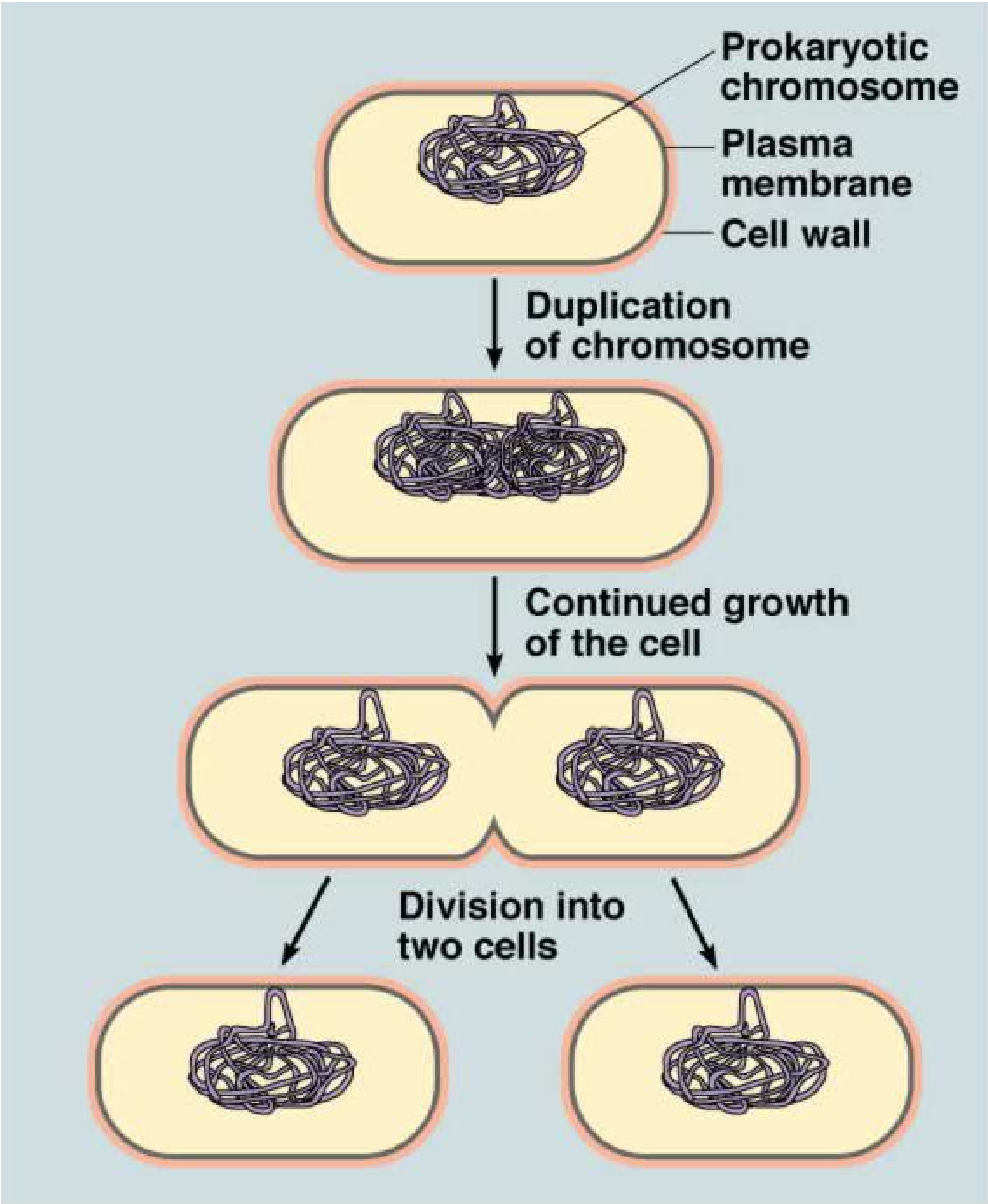
(Some drugs used in chemotherapy destroy the spindle, and prevent the chromatids from reaching the opposite poles)

Telophase



- Chromosomes become long and thin, and then disappear (become invisible) as they re-form chromatin
- Spindle fibres disintegrate
- Nuclear envelope re-forms
- The cytoplasm divides forming two daughter cells - this is called CYTOKINESIS

BINARY FISSION - cell division in prokaryotes (pg 78)



Plasmids inside the cell will also divide, and each will move to one daughter cell = vertical gene transmission

Meiosis

Significance

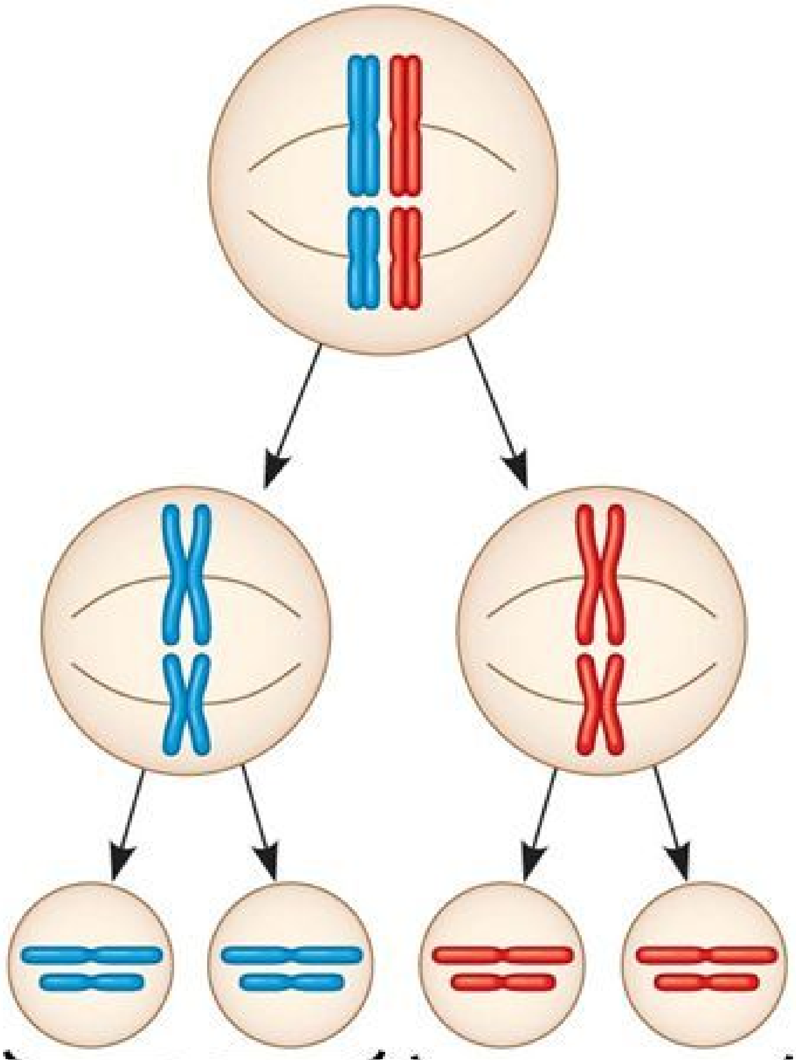
- Halves the number of chromosomes, so that the correct number is restored on fertilisation

Eg. A human cell is diploid (23 pairs/46 chromosomes)
At the end of meiosis, each egg or sperm cell has 23 chromosomes (haploid)
This ensures that when the egg and sperm fuse, the zygote contains the correct number of chromosomes (23 pairs = diploid)

- Creates variation in the population

Each egg/sperm cell is slightly different to the parent.
The offspring produced will have slightly different characteristics to the parents - this helps to create new allele combinations, and new variants of proteins and enzymes, which is important for evolution/adaptation to a changing environment

Meiosis is divided into meiosis I and meiosis II

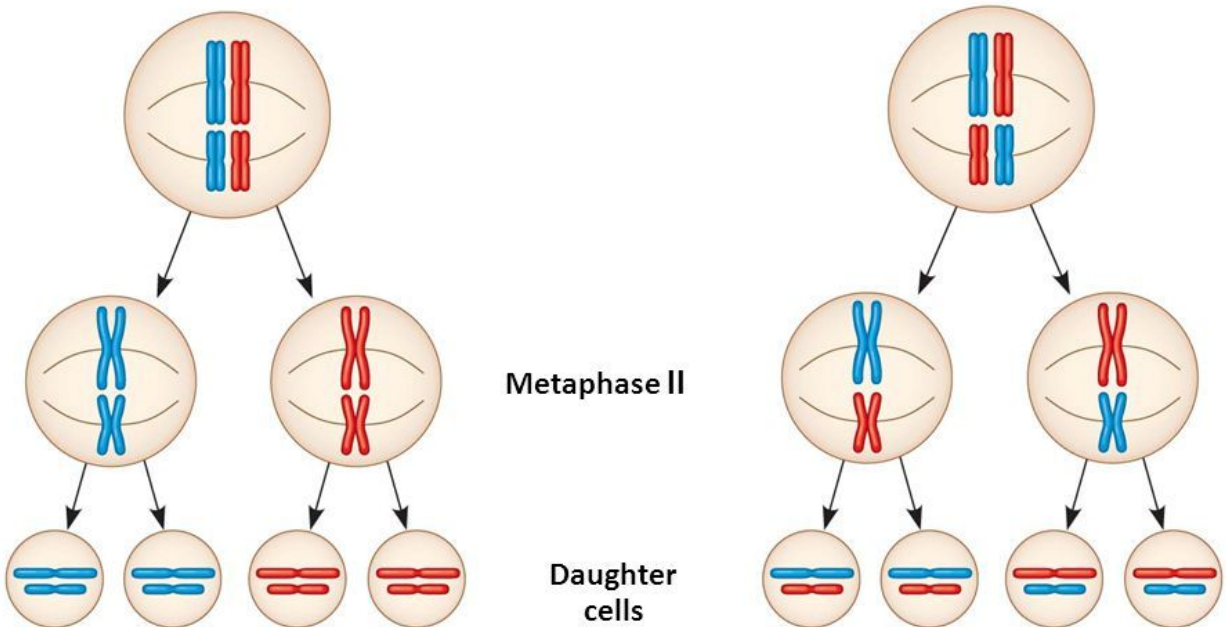


Meiosis I - homologous chromosomes separate (Sister chromatids remain intact)

Meiosis II - sister chromatids separate

Sources of variation during meiosis

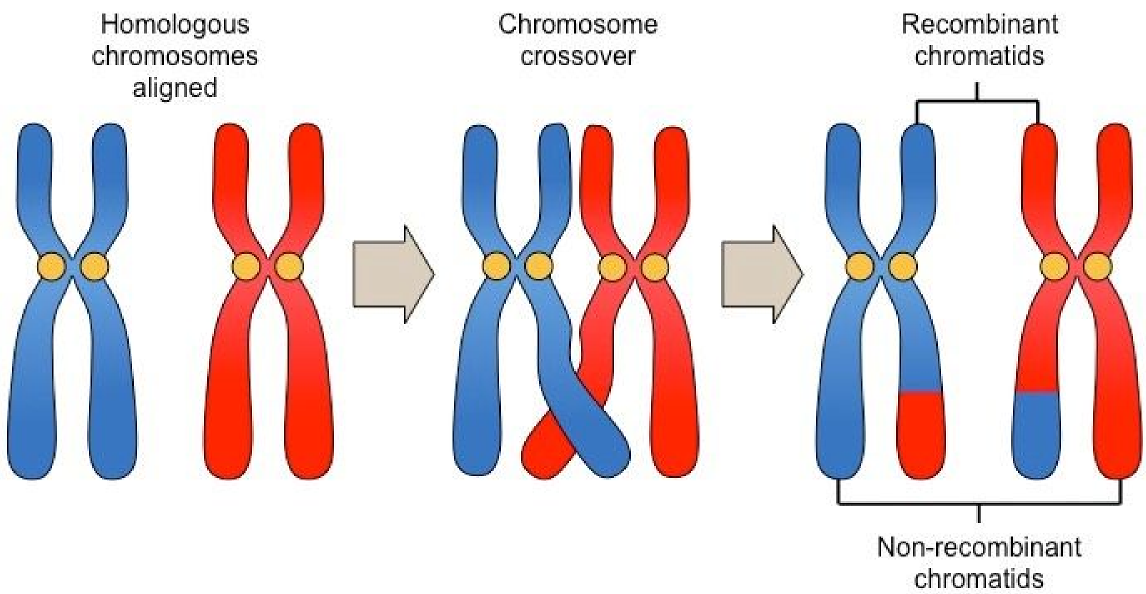
Independent segregation of homologous chromosomes (pg 225) - meiosis I (metaphase I)



Homologous pairs have the freedom to line up randomly along the equator

- Leads to a random combination of maternal and paternal chromosomes in the daughter cell at the end of meiosis I

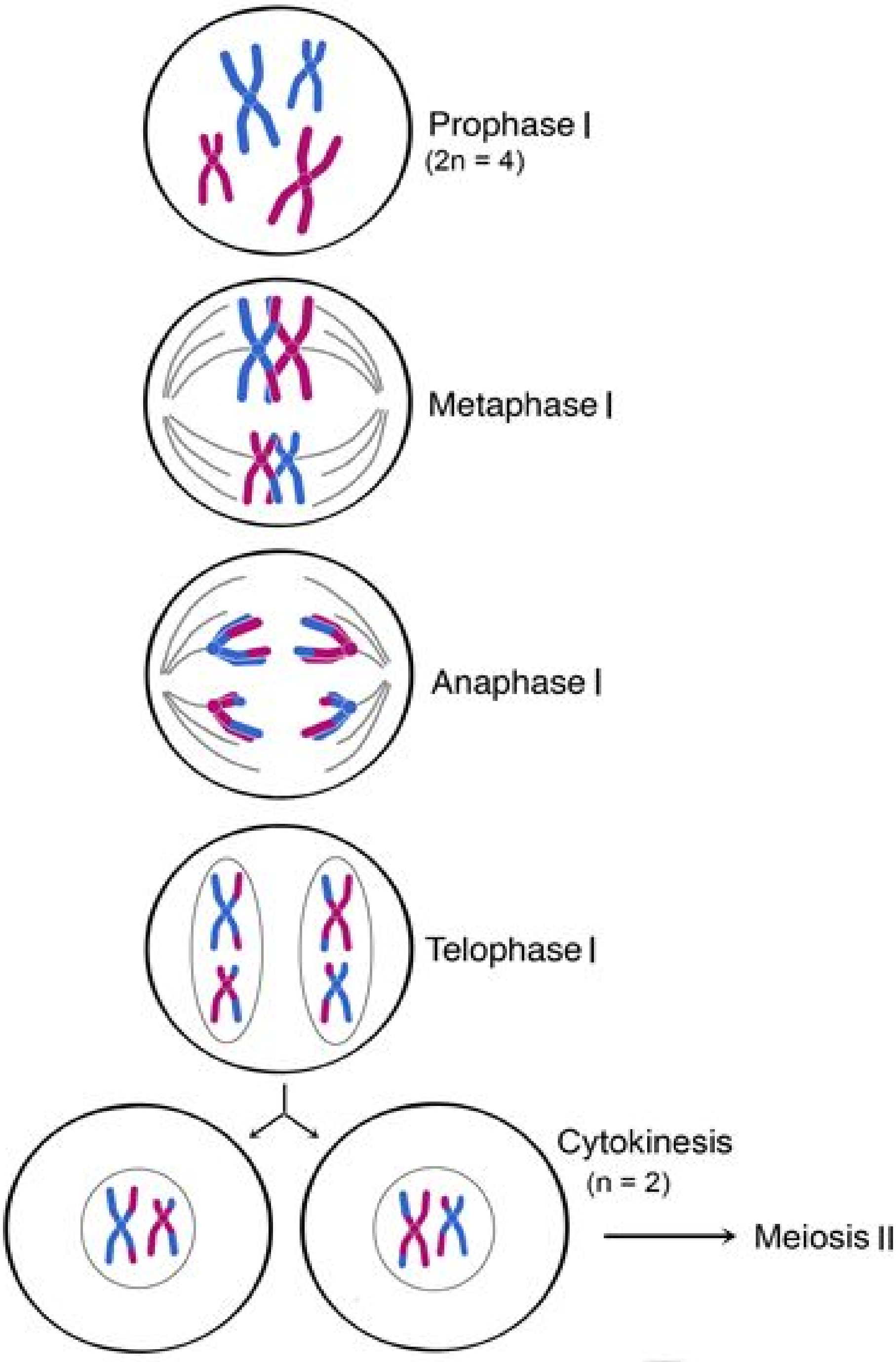
Crossing Over (meiosis I - prophase I)



- Sister chromatids twist around each other, the tension creates breaks in the chromatids
- Equivalent sections of non-sister chromatids may be swapped over
- DNA repair enzymes repair the break
- New allele combinations formed, that did not exist in the parent

Crossing over is a rare event, because breaking and rejoining DNA increases the frequency of mutations.

Meiosis I - overview



Prophase I - crossing over

Metaphase I - homologous chromosomes line up on the equator, independent segregation

Anaphase I - homologous chromosomes pulled to opposite poles

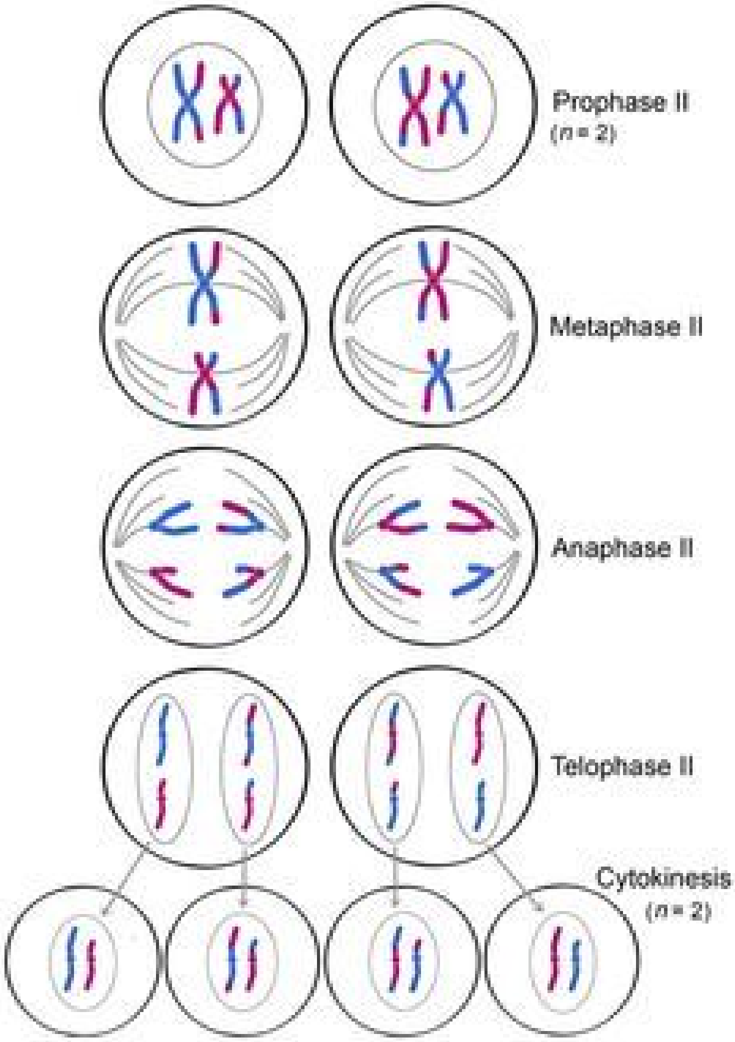
Telophase & cytokinesis - Daughter cells contain one of the pair of homologues

E.g Human cells at the start of meiosis will have 46 duplicated chromosomes (23 duplicated pairs) = diploid

At the end of meiosis I, each daughter cell will have 23 chromosomes, duplicated but not in pairs = haploid

Chromosome number halves (haploid), mass of the cell halves

Meiosis II - identical to mitosis



Chromosome number remains the same (haploid), the mass of the cell halves

Calculating possible chromosome combinations after meiosis

Number of chromosome combinations in the gametes after meiosis = 2^n

Where n = number of homologous pairs

E.g. in humans, 23 pairs will result in

2^{23} = 8388608 combinations

Number of chromosome combinations after fertilisation of the gametes = $(2^n)^2$

In humans, random fusion of the egg and sperm can result in 70368744177664 combinations

Self-study: worked example on pg 228

Self-study: Life cycle of fern, Figure 1, page 224