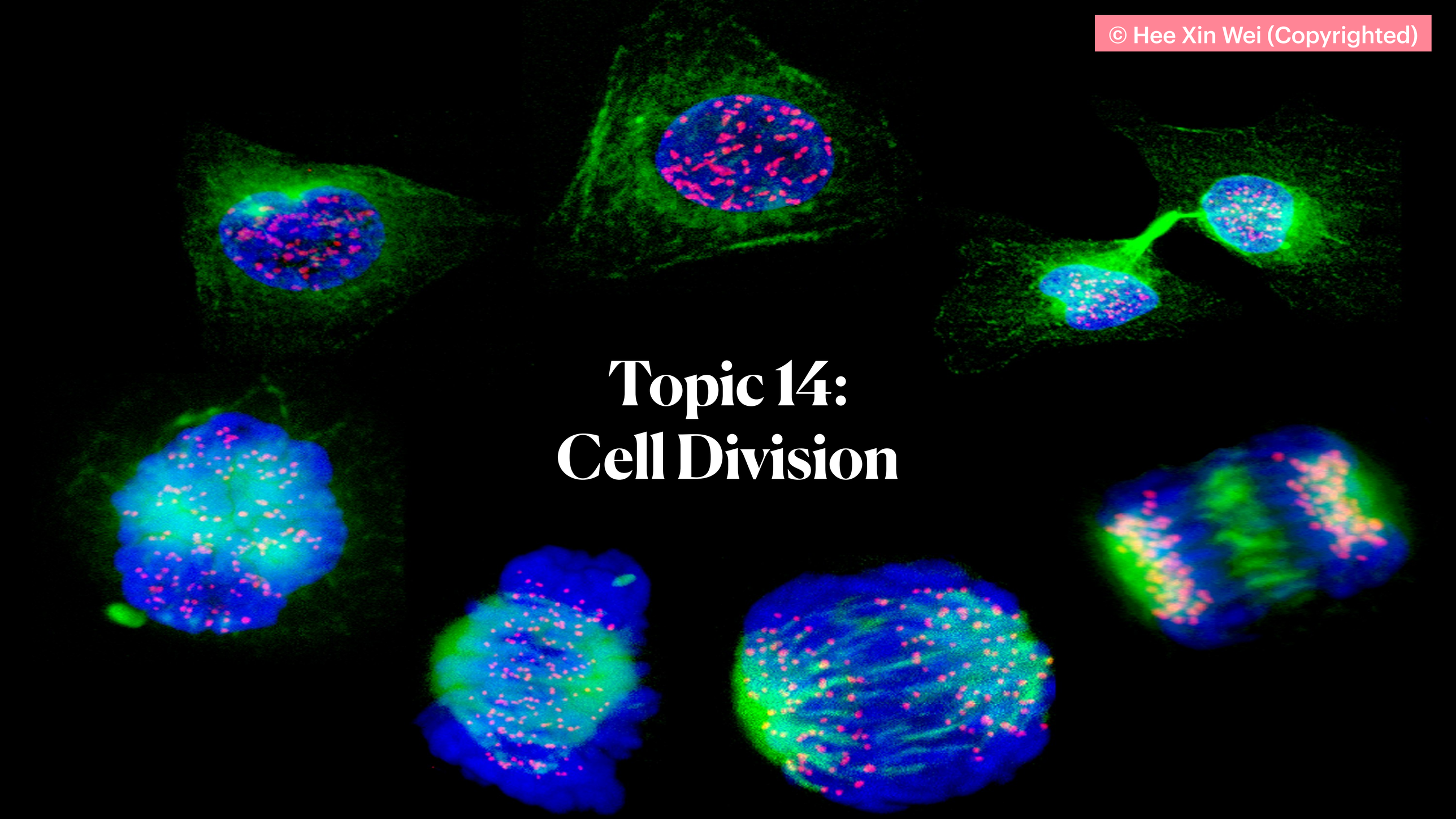
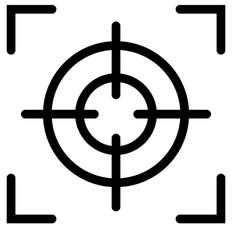


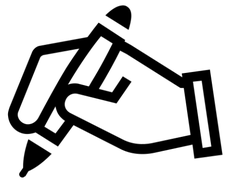
Topic 14:
Cell Division

Chapter Analysis



FOCUS

- content heavy to memorise the full cell cycle
- identifying microscope images



EXAM

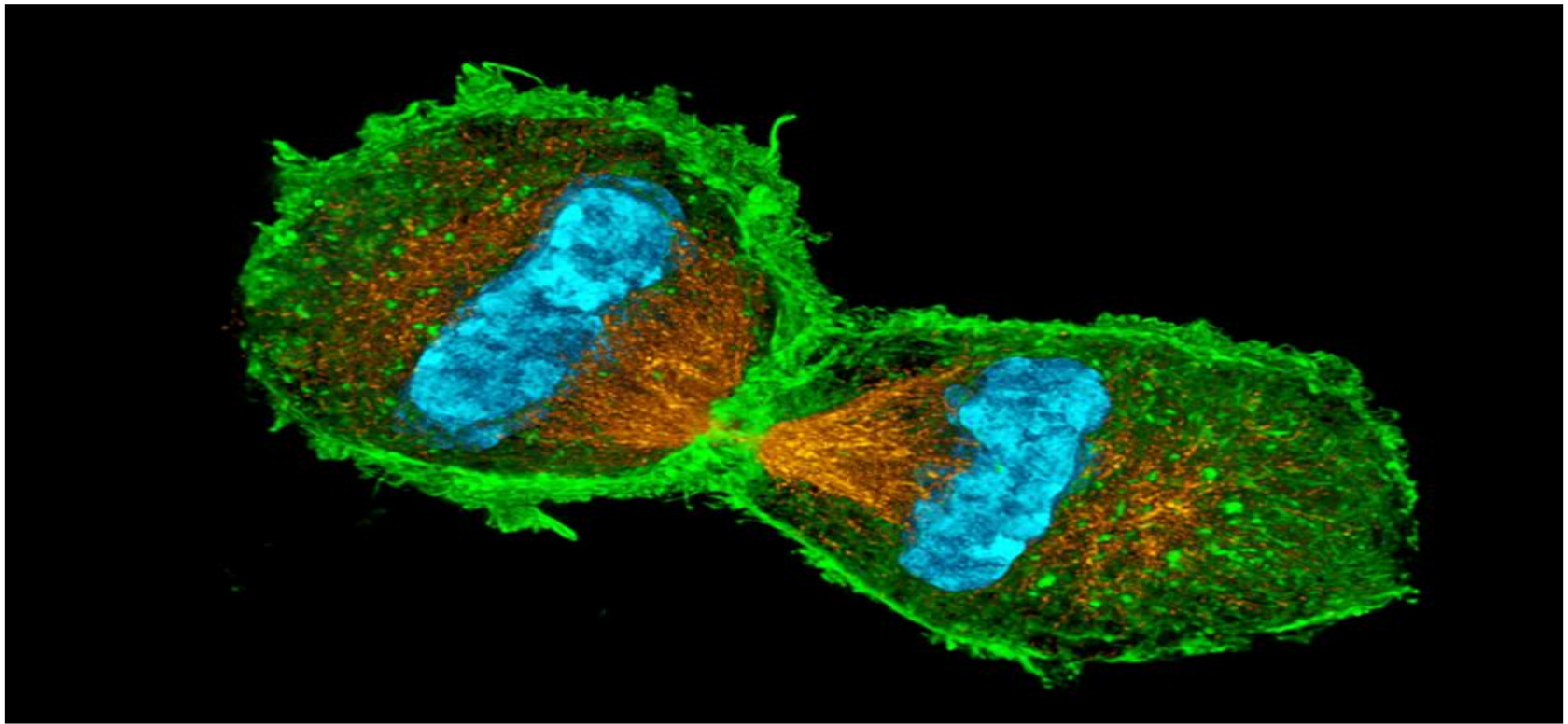
- commonly tested in MCQ and structured questions

WEIGHTAGE

- Constitute to around 3% in Paper 2 in the past 5 years

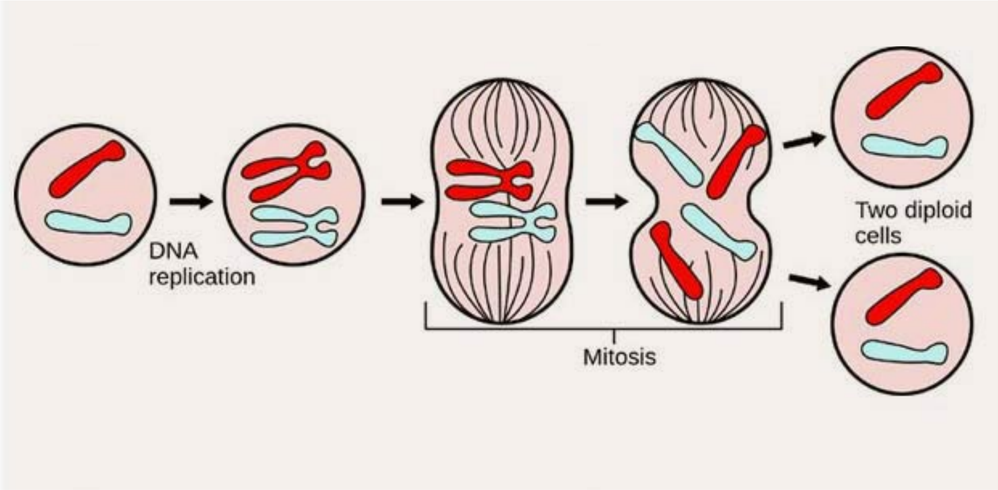
Key Concept

mitosis
meiosis



Mitosis

importance



Mitosis

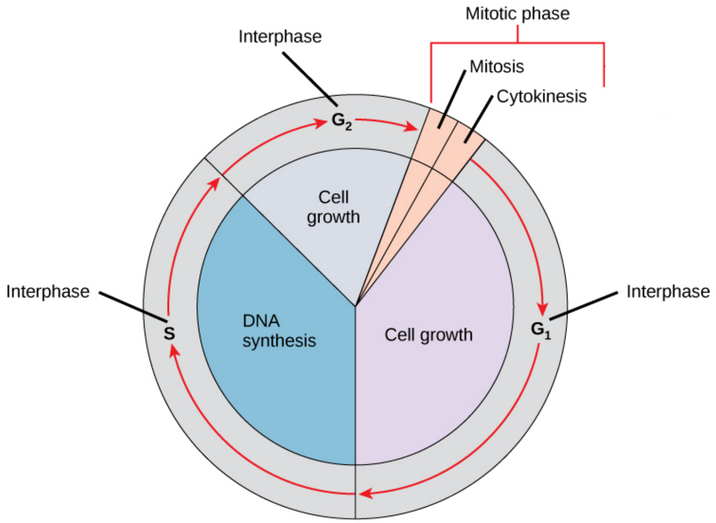
- Mitosis is nuclear division that produces **2 daughter nuclei** that is **genetically identical** to parent nucleus.
- Daughter nuclei have the s**ame number of chromosomes** and same amount of **DNA** as parental nucleus

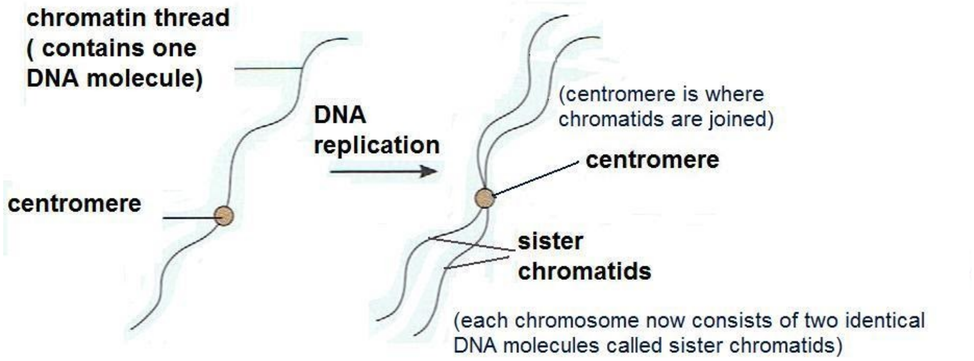
Importance of mitosis

- Producing genetically identical cells is important so the daughter cells will have all the genes necessary
- Mitosis allows growth, repair and asexual reproduction that **requires genetically identical cells.**
  1. **Growth** - Growth requires increase in number of new genetically identical cells within an organism, which is produced by mitosis for it to increase in size
  2. **Repair** - New cells are produced to replace worn out cells that have been shed or to heal from wounds
  3. **Asexual reproduction** - producing offspring that are genetically identical to the parents as well as to one another.

Mitosis

interphase





<u>Interphase (not part of mitosis)</u>

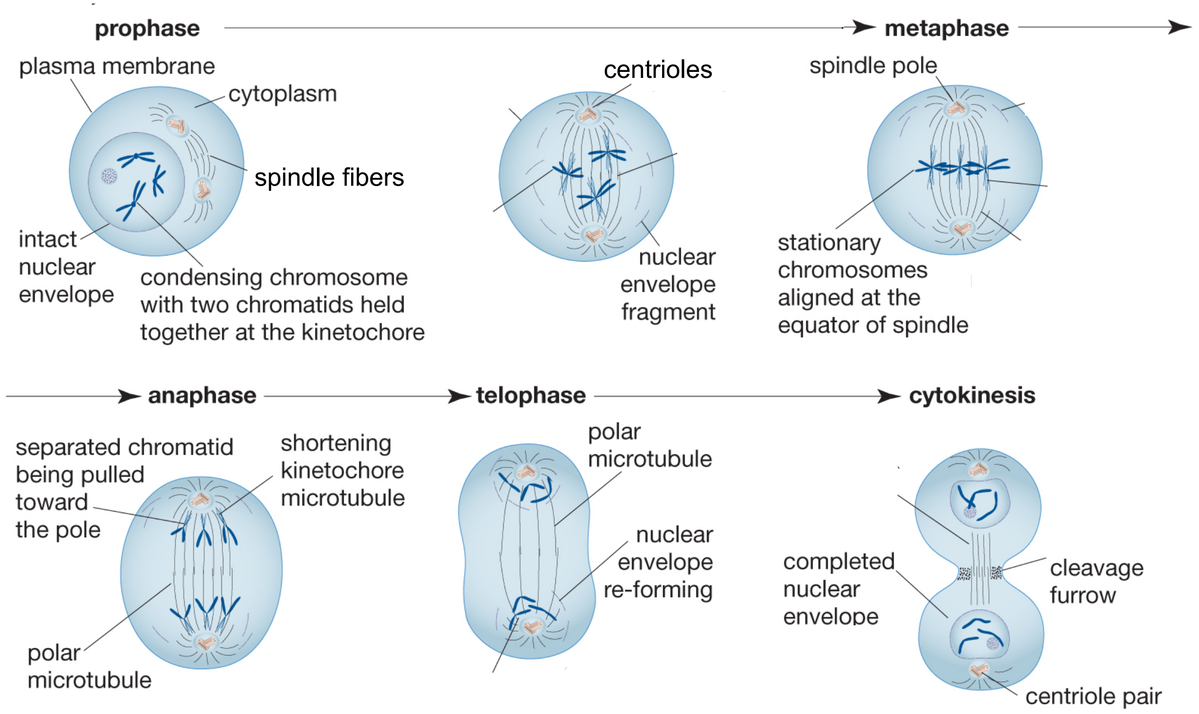
- Cell spends 95% of its time in this phase
- in interphase, the cell prepares for cell division by absorbing nutrients to store energy and building up protoplasm and duplicating organelles
- **The DNA replicates**, producing two **identical chromatin threads** joined at the **centromere**.
- Total **DNA content of the cell doubles**
- Chromosome number still remains 2n

TIPS

✳DNA content is represented by number of sister chromatids

✳Chromosome number is represented by number of centromeres

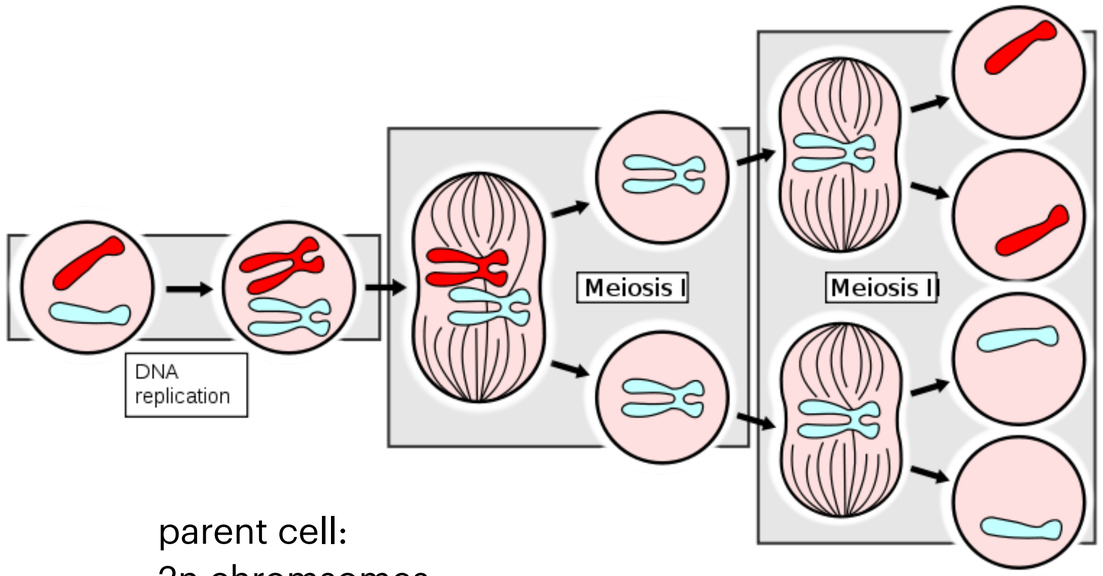
Mitosis



Prophase	• The chromatin condense, coil and shorten to become chromosomes, which are visible under the light microscope. • Each homologous chromosomes consists of two sister chromatids • Nucleolus disappears • The nuclear envelope disintegrates.
Metaphase	• The chromosomes line up along the metaphase plate or equatorial plate • Centromeres are attached to the spindle fibre
Anaphase	• Centromere divides • Aister chromatids splits, they are now called a daughter chromosome.
Telophase	• Nuclear envelope forms around the chromosomes at each pole of the cell. • Nucleolus reforms in each nucleus • The chromosomes in each daughter nucleus uncoil and lengthen to form chromatin threads.
Cytokinesis	• Cleavage furrows appear in the the cytoplasm between the two nuclei. The furrows deepen and two identical daughter cells are produced. • In plant cells, a cell plate is formed between the two daughter nuclei, dividing the cell into two. Cell plate is formed by the fusion of small fluid-filled vesicles produced by the Golgi apparatus.

Meiosis

phase I



parent cell:
2n chromsomes

daughter cells:
n chromosomes

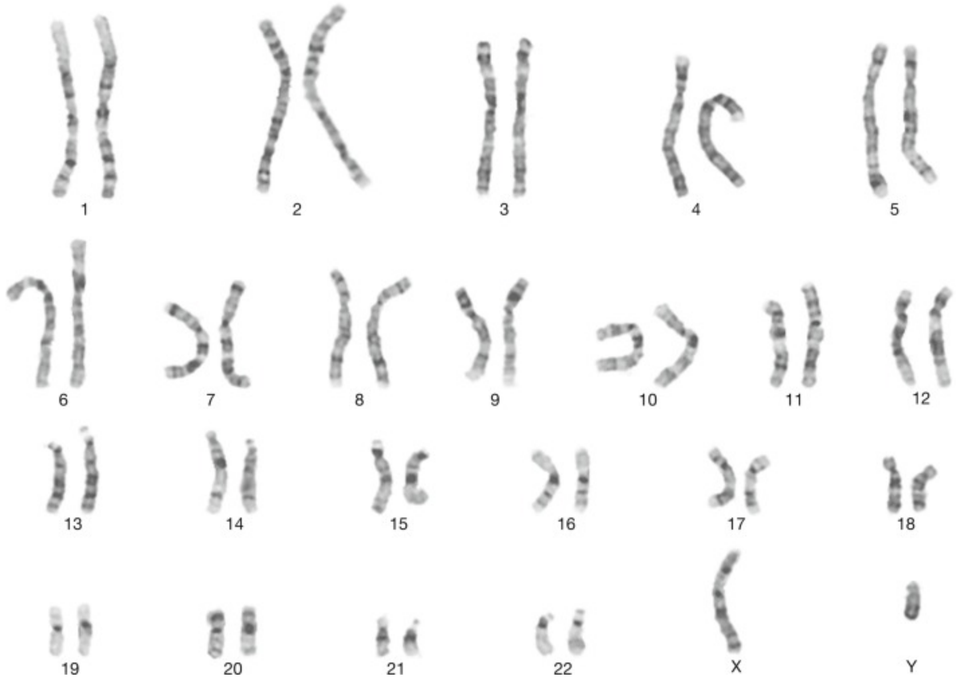
Meiosis

- Meiosis is a **reduction** nuclear division that produces daughter nuclei containing **half the number of chromosomes** as the parent nucleus.
- A parent nucleus undergoes meiosis to give **4 daughter nuclei (gametes)**
- Interphase also occurs prior to meiosis

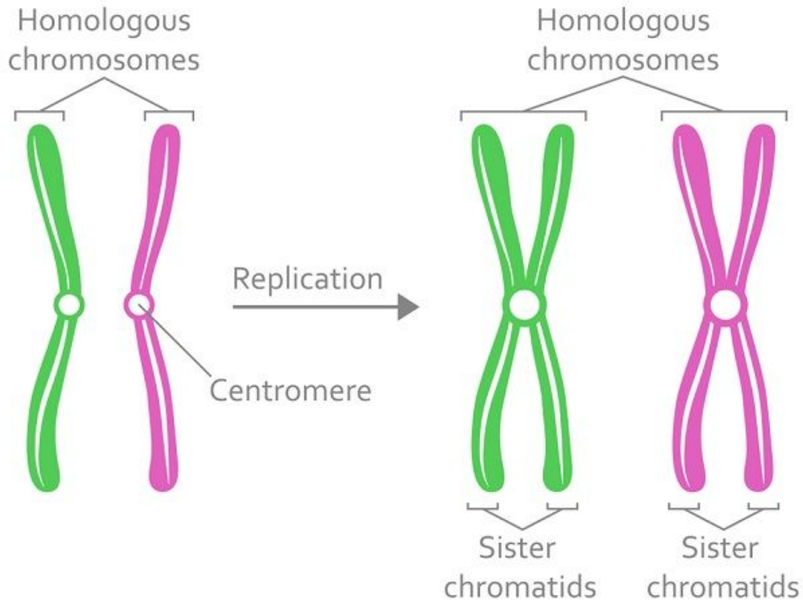
Gametes

- Gametes are **haploid cells** which means it contains half the number of chromosomes as compared to normal body cell
- For example, a human cell has **diploid number** of chromosomes, **23 pairs** of chromosomes, **46 chromosomes**, undergo meiosis to give 4 human gametes that each have 23 chromosomes.

Homologous Chromosomes



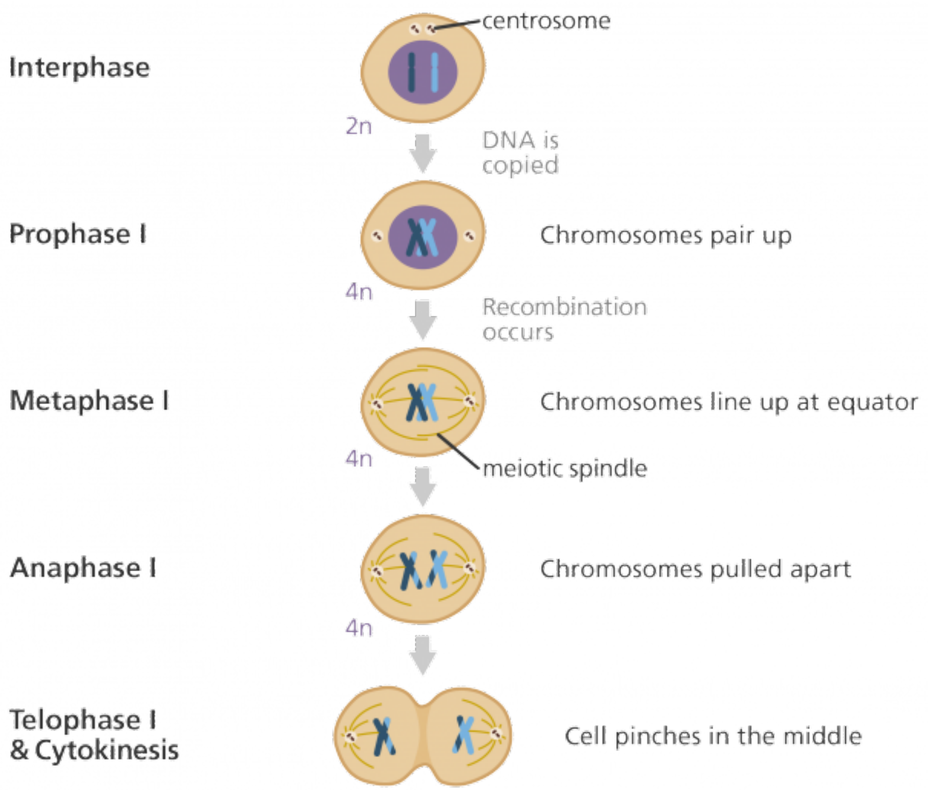
human has 23 pairs of homologous chromosomes



- A pair of chromosomes of the same shape, same length, same centromere position and have the same genes with the same corresponding loci.
- One chromosome is inherited from the maternal parent, while another one from the pair is inherited from paternal parent
- Homologous chromsomes may contain different types of alleles

Meiosis

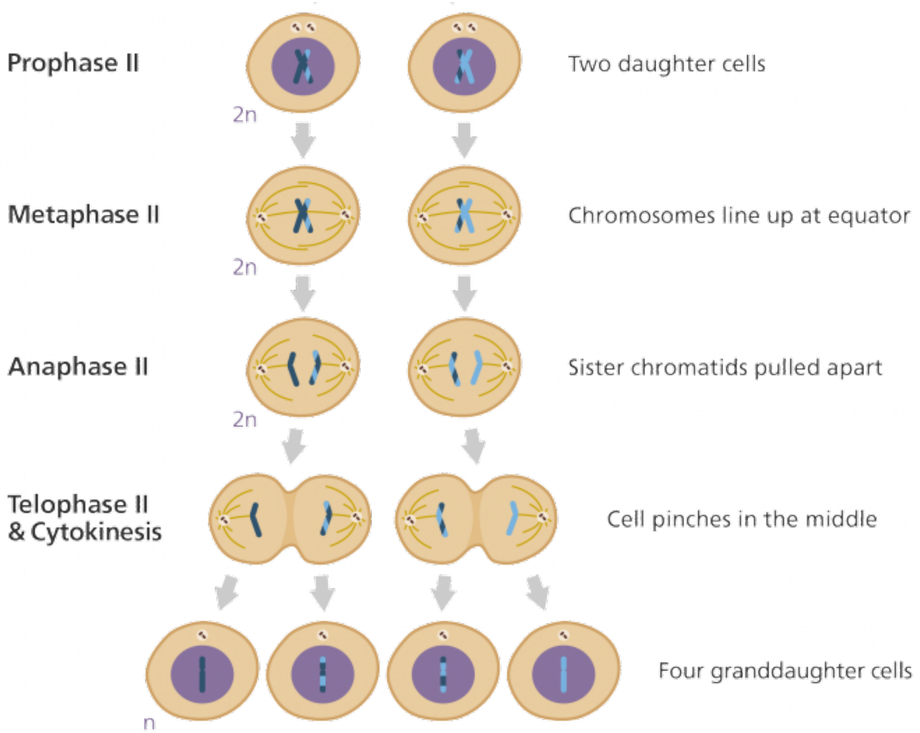
phase I



Prophase I	• The chromatin condense, coil and shorten to become chromosomes, which are visible under the light microscope. • Synapsis occurs where homologous chromosomes pair up • Crossing-over may occur where some DNA is exchanged at chiasma between homologous chromosomes • Nucleolus disappears • The nuclear envelope disintegrates.
Metaphase I	• The homologous chromosomes line up in pairs along the metaphase plate. • homologous chromsomes independently arrange themselves along the metaphase plate
Anaphase I	• Homologous chromosomes separate and move to opposite poles of the cell.
Telophase I	• Nuclear membranes form around the chromosomes at each pole of the cell. • The chromosomes uncoil and lengthen to form chromatin threads.
Cytokinesis	• Cleavage furrow forms in animal cell or cell plate in plant cell, dividing the cell. • the number of chromosomes is already halved at the end of meiosis 1

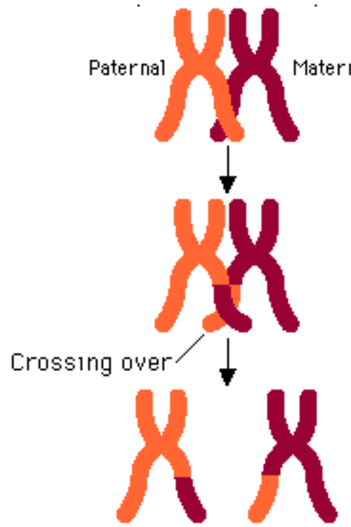
Meiosis

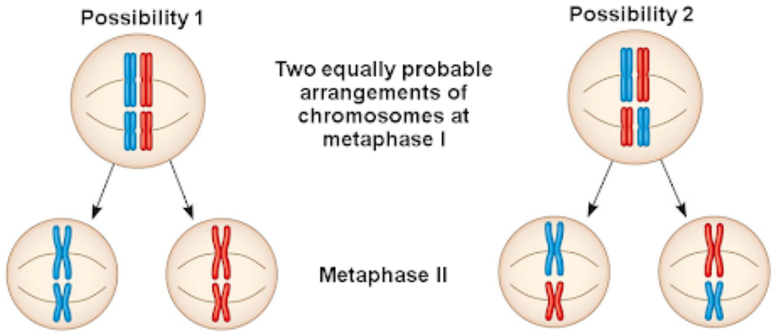
phase II



Prophase II	• The chromatin condense, coil and shorten to become chromosomes, which are visible under the light microscope. • The nuclear envelope disintegrates.
Metaphase II	• The chromosomes line up along the metaphase plate or equatorial plate
Anaphase II	• Centromere divides • Spindle fibres shorten and separates the sister chromatids and pull to the opposite poles of the cell, forming sister chromosomes
Telophase II	• Nuclear envelope forms around the chromosomes at each pole of the cell. • Nucleolus reforms in each nucleus • The chromosomes in each daughter nucleus uncoil and lengthen to form chromatin threads.
Cytokinesis	• Cleavage furrows appear in the the cytoplasm between the two nuclei. The furrows deepen and two identical daughter cells are produced. The end product of meiosis is 4 daughter cells. • The daughter cells have haploid number of chromosomes and x/2 amount of DNA.

meiosis





importance of meiosis

1. Produce **haploid gametes**
   - During meiosis, diploid cells undergo **2 nuclear divisions** - meiosis I and meiosis II to give **4 haploid gametes**
   - During **fertilisation**, **normal diploid number of chromosomes is restored** when a male gamete fuses with a female gamete
   - If meiosis did not occur, chromosome number would double, thus meiosis ensures the **maintenance of chromosome number** of offspring

2. Meiosis results in **genetic variation** in gametes
   - **Crossing-over** between homologous chromosomes during prophase I of meiosis. Crossing-over results in genetic recombination, producing chromosomes that have a mixture of maternal and paternal DNA.
   - **Independent assortment** of homologous chromosomes during metaphase I of meiosis results in different combination of maternal and paternal chromosomes.
   - **Random fusion of gametes during fertilisation** will produce variation due to the many different combinations of genes from the male and female gamete, thus a variety of genotype and phenotype of offspring
   - Genetic variation from meiosis and fertilisation **increases the chances of survival of the species**. Those with favourable gene will be more likely to survive and pass on its favourable genes to offspring. It is especially important in a changing environment

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