CELL DIVISION:
MEIOSIS

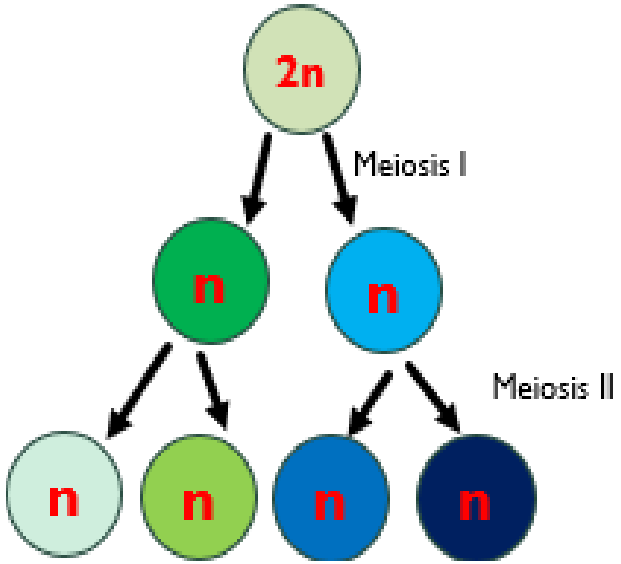
Lecture Book 4
Pg **23**

LEARNING OBJECTIVES:

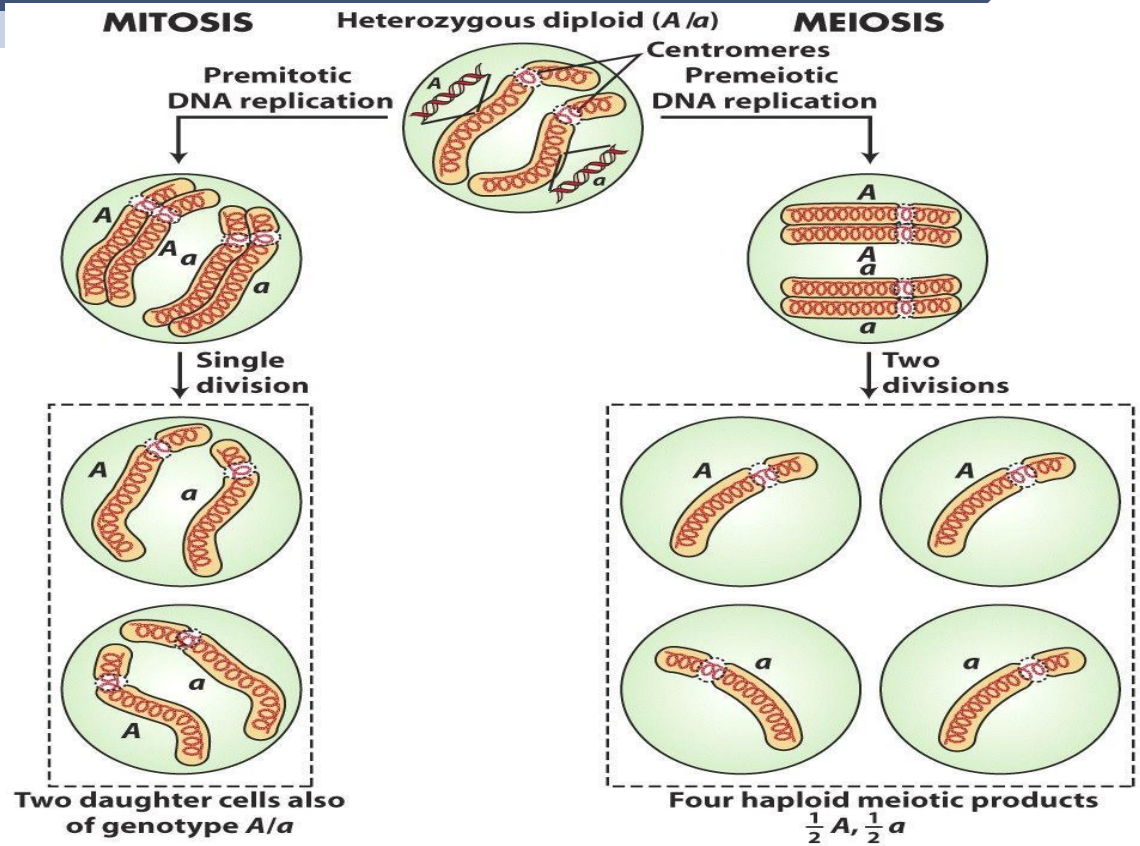
2 (j) Explain the **significance** of the **meiotic cell cycle** (reduction division prior to fertilisation and cells not genetically identical) and that meiosis and random fertilisation can lead to variation (detailed description of the behaviour of chromosomes during meiosis is not required. Information about the stages and associated behaviour of the nuclear envelope, cell surface membrane and centrioles is not required.)

MEIOSIS DEFINITION

- **Reduction division** that produces **4 daughter nuclei** are not genetically identical
- Each have **half** the number of chromosomes as that of the parent nucleus
- Has 2 consecutive cycles of **nuclear division** – MEIOSIS I & MEIOSIS II



MITOSIS vs MEIOSIS



MITOSIS vs MEIOSIS

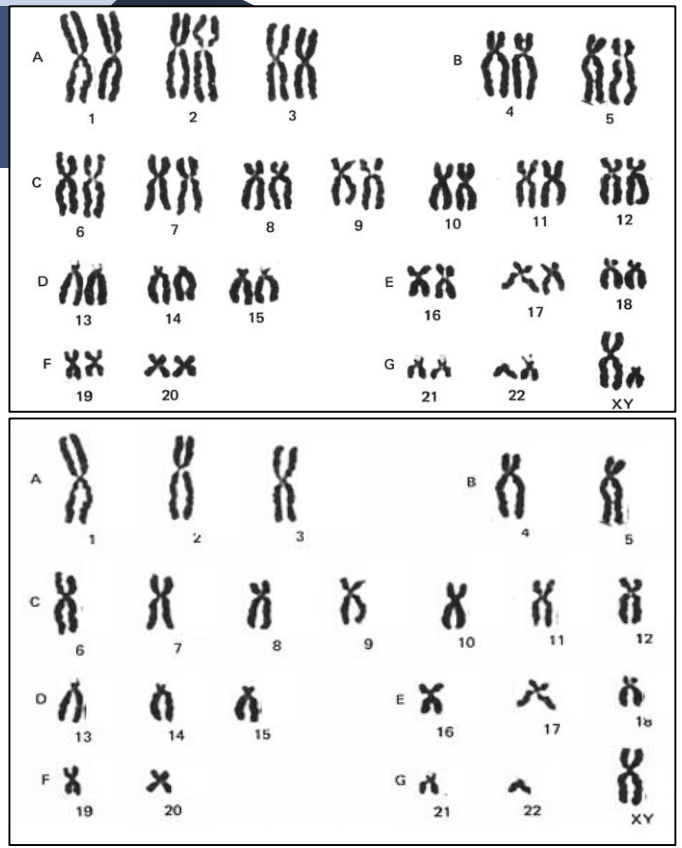
- **Mitosis** may occur in almost any living cell (somatic cells)
- **Meiosis** is **restricted to germ-line cells that form haploid gametes** (i.e. the eggs and sperm).

Gametes undergo meiosis ✗

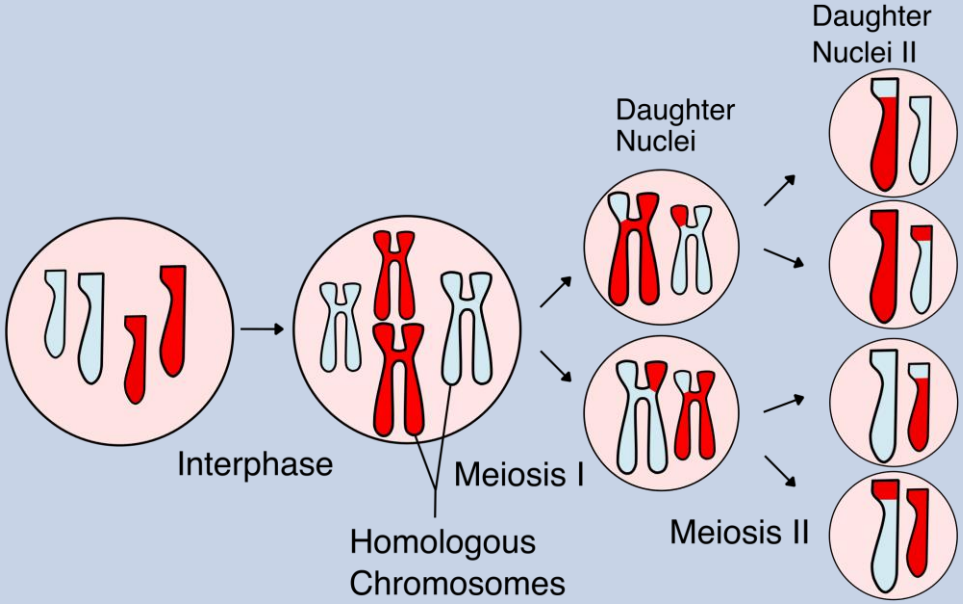
Germ-line cells undergo meiosis to form gametes ✓
[Gametocytes/ Gametogonia]c

REVISION: PLOIDY

- Defined by the **number of sets of chromosomes**
- **Diploid** = 2 sets of homologous chromosomes
- **Haploid** = 1 set
- TIP: Count number of chromosomes by **counting the no. of centromeres**



RECAP



MEIOSIS phases

PAGES 24 – 28
FYI only

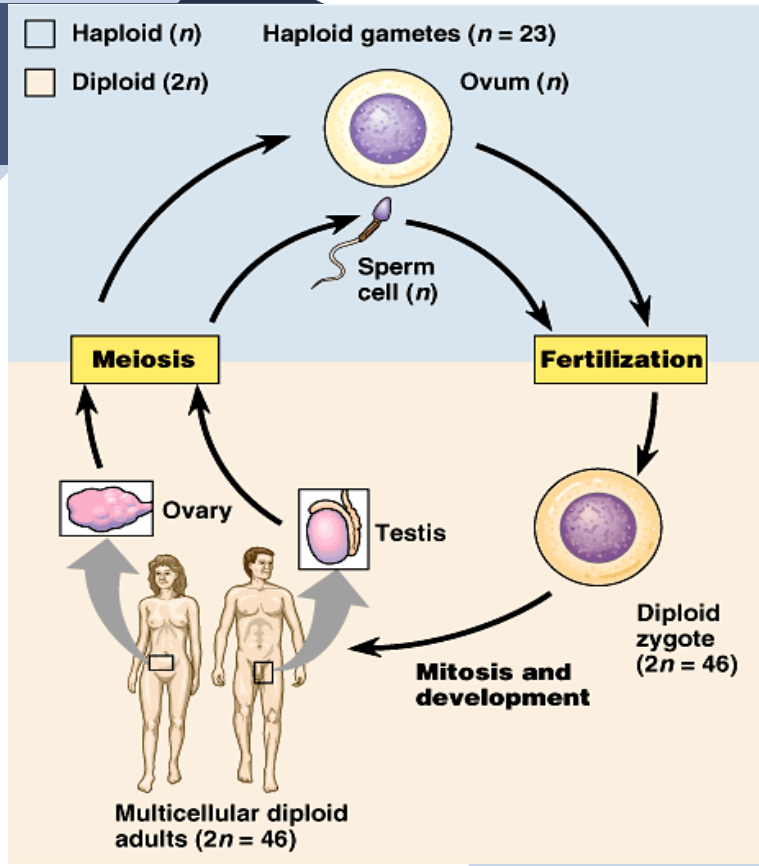
IMPORTANCE OF MEIOSIS

WHY DO WE NEED MEIOSIS?

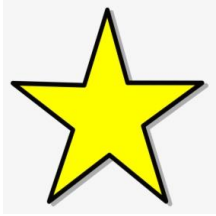
- Importance of Meiosis
  - Haploid Gametes
    - Sexual Reproduction to restore diploidy
  - Genetic Variation in Gametes
    - Crossing Over @ Prophase I
    - Independent Assortment @ Metaphase I & II

I) SEXUAL REPRODUCTION

- Meiosis + Cytokinesis produce **haploid gametes (n)**
- Fusion of gametes during **fertilisation restores diploid condition (2n)**
- Ensure chromosome number remains the same and **prevents doubling**



II) GENETIC VARIATION IN SEXUALLY REPRODUCING ORGANISMS



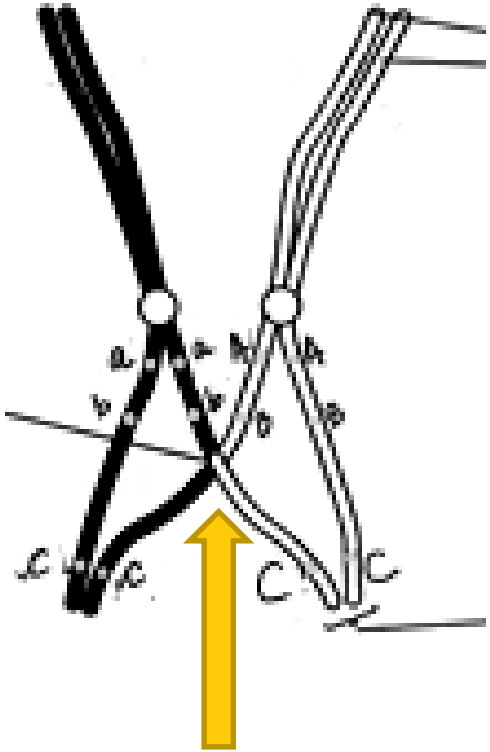
- Sources:
  - **a) Meiosis**
    - i. Crossing Over
    - ii. Independent Assortment
  - **b) Random Fertilisation**

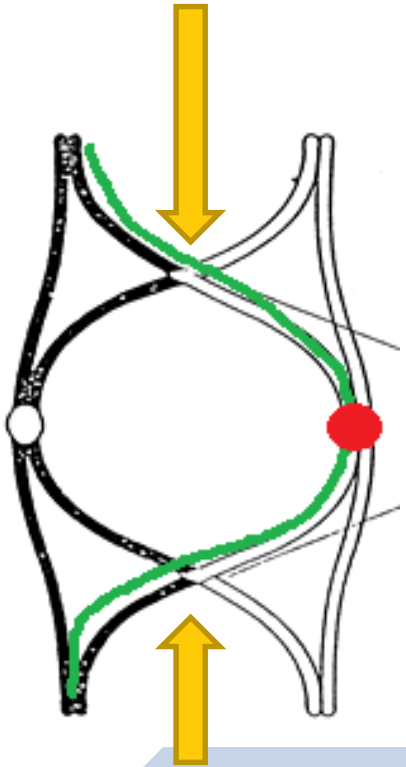
Results in new alleles
[only possible due to mutations]

- Results in **new combination of alleles** in gametes after meiosis + in offsprings after fertilisation

1. CROSSING OVER

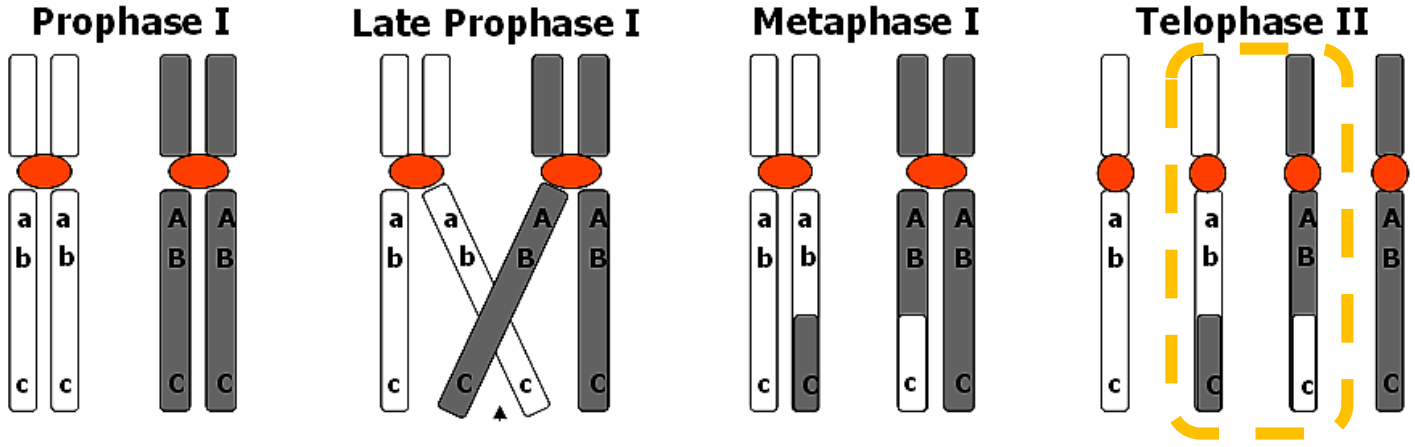
- When – **Prophase I** of Meiosis I
- Where – @ **chiasmata** of **non-sister chromatids** of **homologous chromosomes**





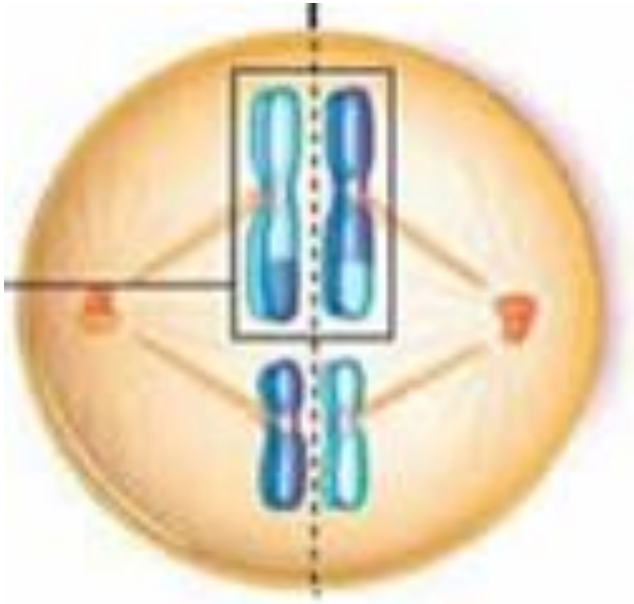
1. CROSSING OVER

- Results in **exchange of equivalent parts of chromatids** => exchange of alleles
- Results in chromosomes with a **new combination of alleles**

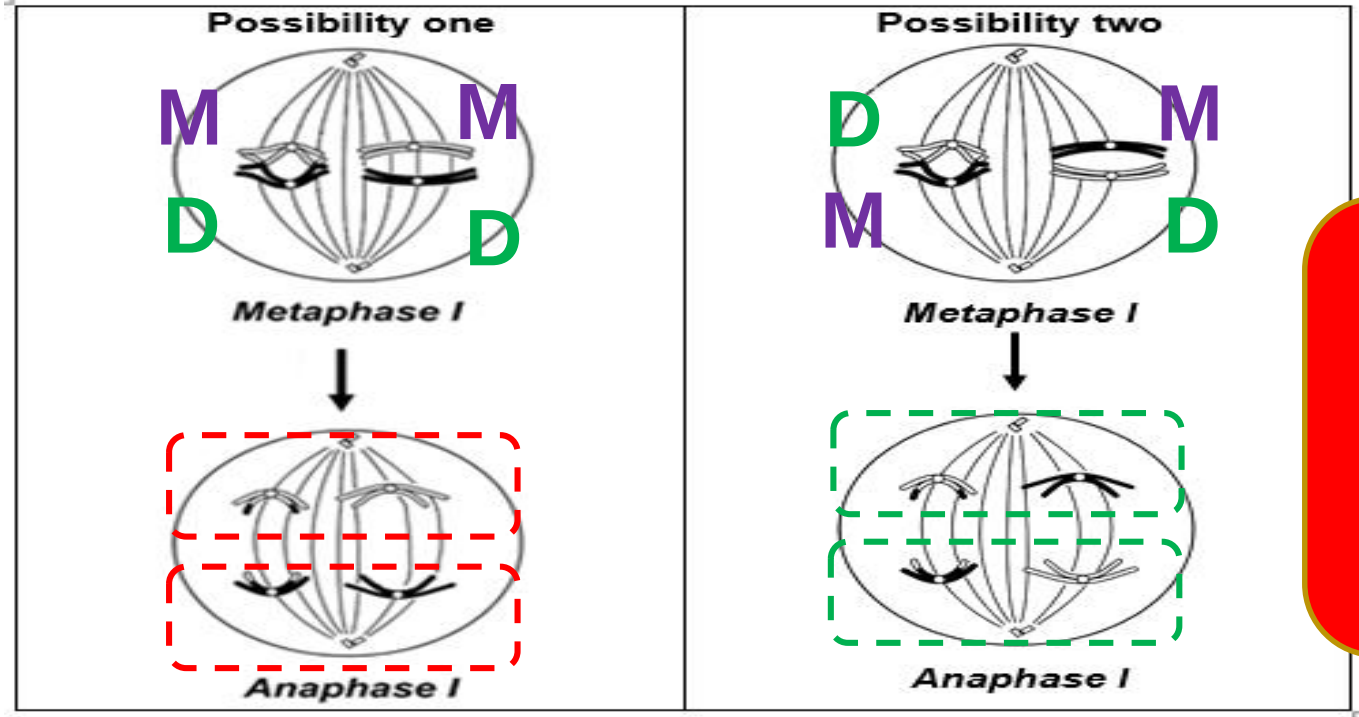


2. INDEPENDENT ASSORTMENT OF HOMOLOGOUS CHROMOSOMES

- When – **Metaphase I & Anaphase I**
- Where – Along metaphase plate
- Homologous pairs **orientate** independently of each other
- This **random** **arrangement** and subsequent **separation at metaphase I and anaphase I respectively** = independent assortment



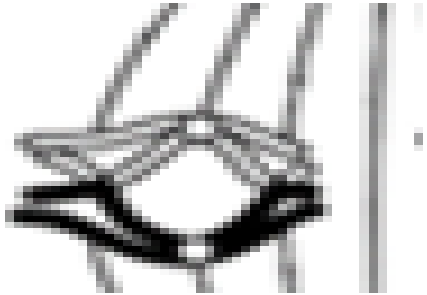
2. INDEPENDENT ASSORTMENT OF HOMOLOGOUS CHROMOSOMES



2 x 2

2 homologous pairs ↓ 4 diff. combi

2. INDEPENDENT ASSORTMENT OF HOMOLOGOUS CHROMOSOMES



Effect of Independent Assortment

- **2^n possible combinations** 2 x 2 x 2 …

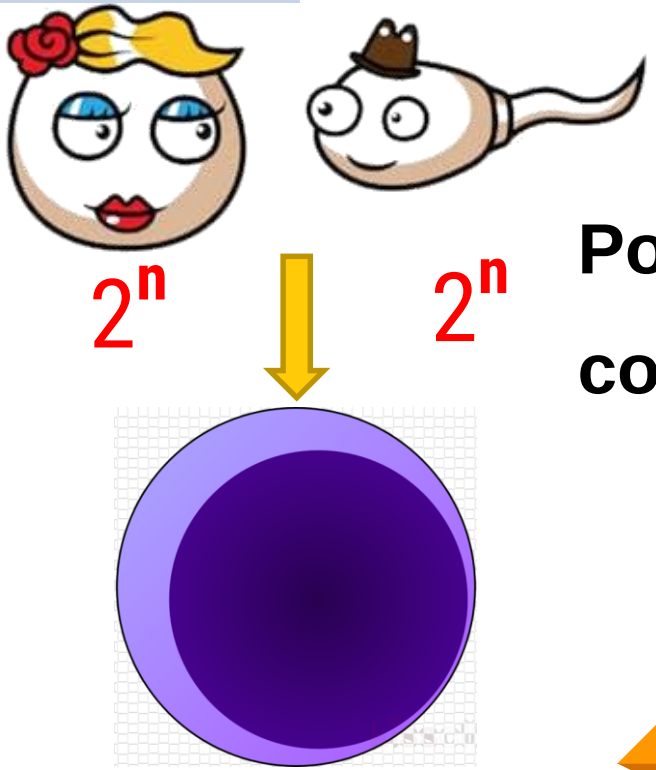
  of chromosomes in daughter cells where **n is the haploid number** of chromosomes.

- In humans, haploid number of chromosomes = **23**

  So, each gamete can have 2^{23} = 8,388,608 possible combinations of chromosomes

3. RANDOM FERTILISATION

- **Random fusion** of gametes
- $(8{,}388{,}608)^2$ possible diploid combinations in a zygote formed
- Factor in variation from <u>crossing over</u> → *Astronomical possibilities*



Possible combinations

LEARNING OBJECTIVES:

2 (j) Explain the **significance** of the **meiotic cell cycle** (reduction division prior to fertilisation and cells not genetically identical) and that meiosis and random fertilisation can lead to variation (detailed description of the behaviour of chromosomes during meiosis is not required. Information about the stages and associated behaviour of the nuclear envelope, cell surface membrane and centrioles is not required.)