



# Meiosis Overview

## Part A Chromosome copies

Meiosis is a unique form of cell division in which one  cell (a cell with 2 copies of each chromosome) undergoes  rounds of division to produce   cells (cells with 1 copy of each chromosome).

In most sexually reproducing organisms, this is how  are made. Two of these cells then combine during fertilisation to form a  zygote.

Items:

haploid

diploid

two

four

gametes

## Part B Meiosis I

One complete round of meiosis involves two rounds of cell division. These are called meiosis I and meiosis II. Each of these are similar to mitosis, but with a few differences.

During , homologous chromosomes bind to each other at points along the chromosomes called . Regions of one chromosome may then switch with the same regions on the other chromosome, in a process called "".

During , chromosomes line up in homologous pairs, rather than as individual chromosomes. And during , the homologous chromosomes are then pulled apart (instead of sister chromatids being pulled apart).

During  the nuclear membranes form around the double-chromatid chromosomes at opposite ends of the cell (which uncoil into chromatin), and then the cell splits into two by cytokinesis.

Items:

prophase I

crossing over

anaphase I

telophase I

centromeres

metaphase I

nondisjunction

chiasmata

## Part C Meiosis II

Meiosis II is much more similar to mitosis.

During  the chromatin condenses into chromosomes. These then line up in the middle of the cells as individual chromosomes during , and are pulled apart into sister chromatids during  (though, because of crossing over during meiosis I, the sister chromatids of each chromosome may not be identical to each other).

During  the nuclear membranes form around the single-chromatid chromosomes at opposite ends of the cell (which uncoil into chromatin), and then the cell splits into two by cytokinesis.

Items:

prophase II

anaphase II

metaphase II

telophase II



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# Mitosis vs Meiosis

A Level

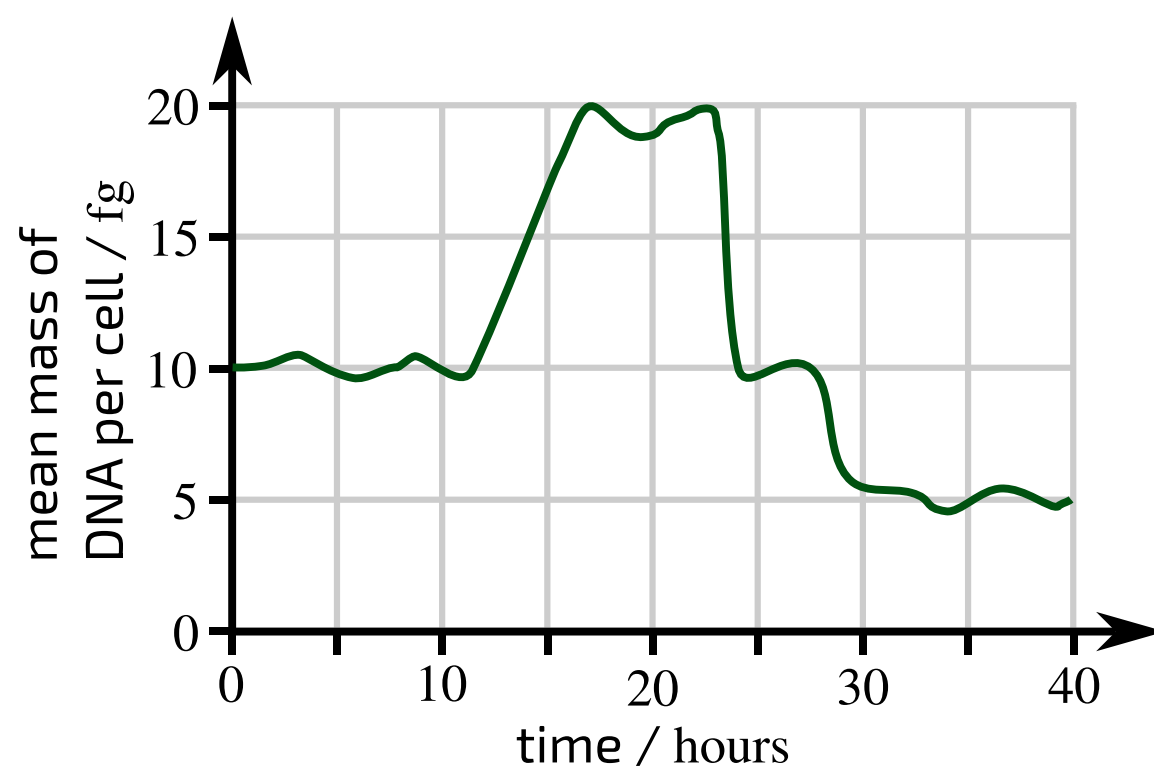


## Part A Meiosis functions

Which of the following describe meiosis in humans?

- ☐ the fusion of two gametes to form a zygote
- ☐ cell division of a zygote to form an embryo
- ☐ producing haploid cells from diploid cells
- ☐ asexual reproduction
- ☐ tissue growth & repair
- ☐ producing gametes

## Part B DNA & division



**Figure 1:** The mean mass of DNA of a population of cells dividing at the same time, measured in femtograms ( $10^{-15}$  g) per cell.

Which of these processes are shown in Figure 1? Select all that apply.

- ☐ mitosis
- ☐ DNA replication
- ☐ fertilisation
- ☐ cytokinesis
- ☐ interphase
- ☐ meiosis

Part C True or false?

In the table below, identify which events occur during mitosis, meiosis I, and meiosis II. Fill in every box with either a tick (event occurs) or a cross (event does not occur).

	Mitosis	Meiosis I	Meiosis II
homologous chromosomes pair up	<input type="text"/>	<input type="text"/>	<input type="text"/>
crossing over occurs	<input type="text"/>	<input type="text"/>	<input type="text"/>
chromatids separate	<input type="text"/>	<input type="text"/>	<input type="text"/>

Items:

☐

☐

Question elements adapted with permission from NSAA 2020 Section 2 Q55 & OCR January 2002 Science Modular Biology Foundation Q1

Gameboard:

STEM SMART Biology Week 10

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# Stages of Meiosis

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A Level

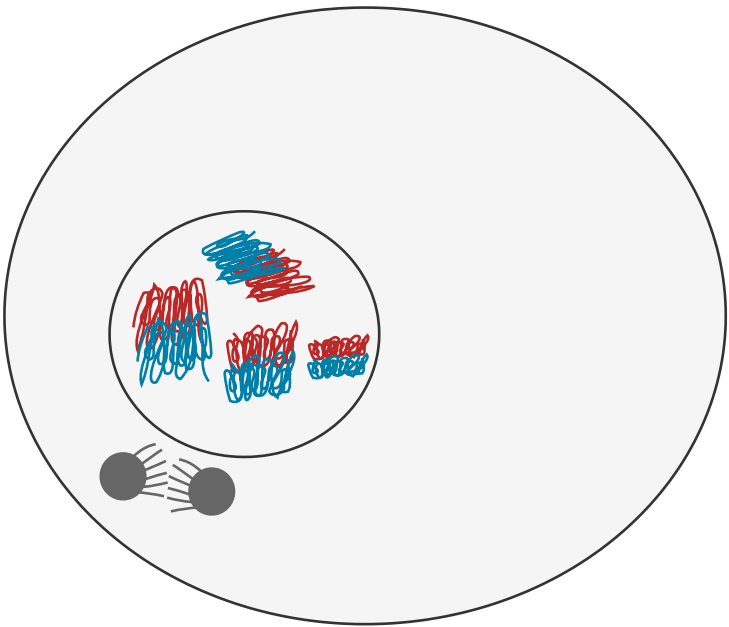
C

C

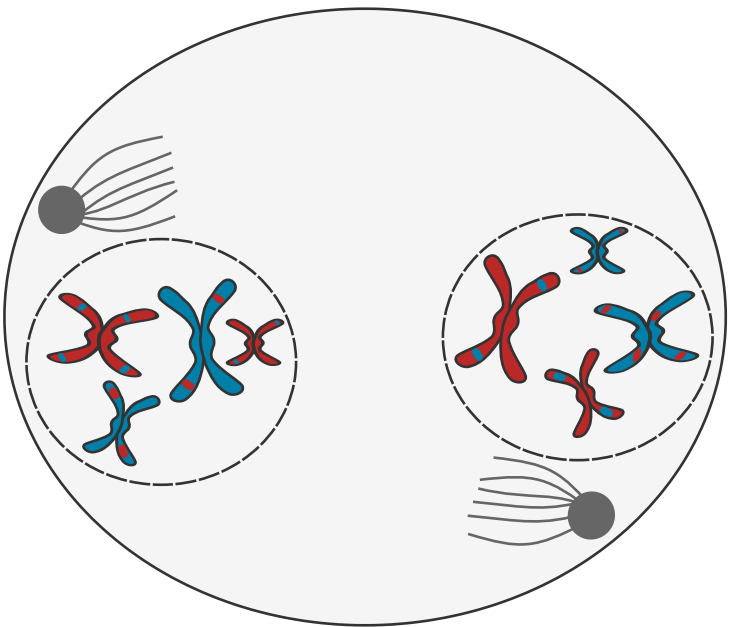
C

Part A    Meiosis I

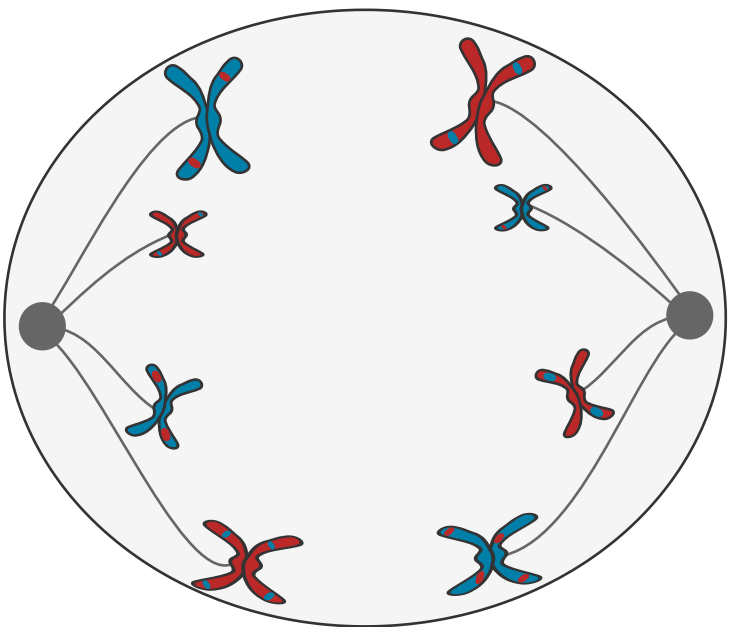
The images below represent different stages of meiosis I, for an organism with a diploid chromosome number of 8.



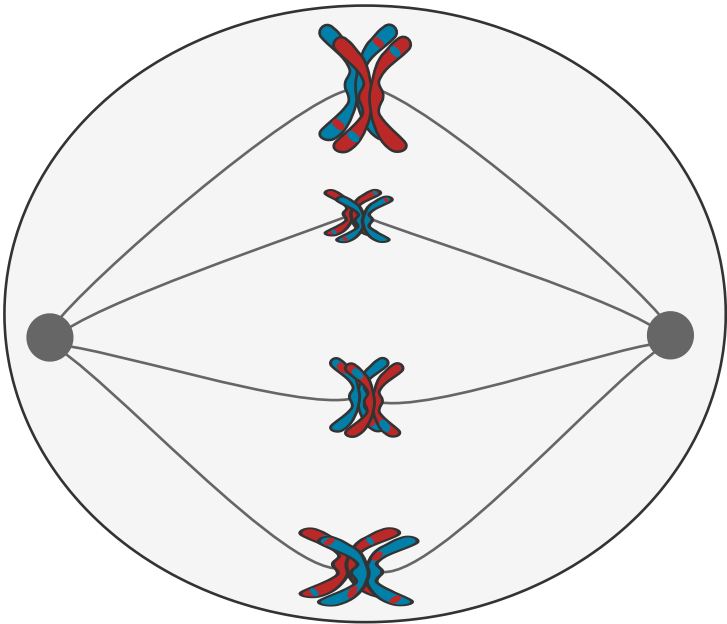
A



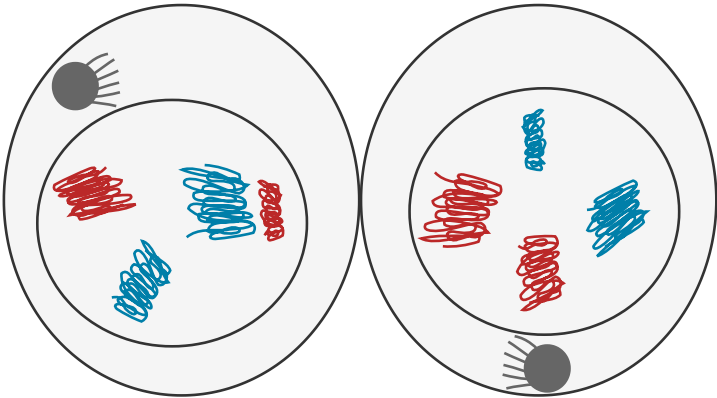
B



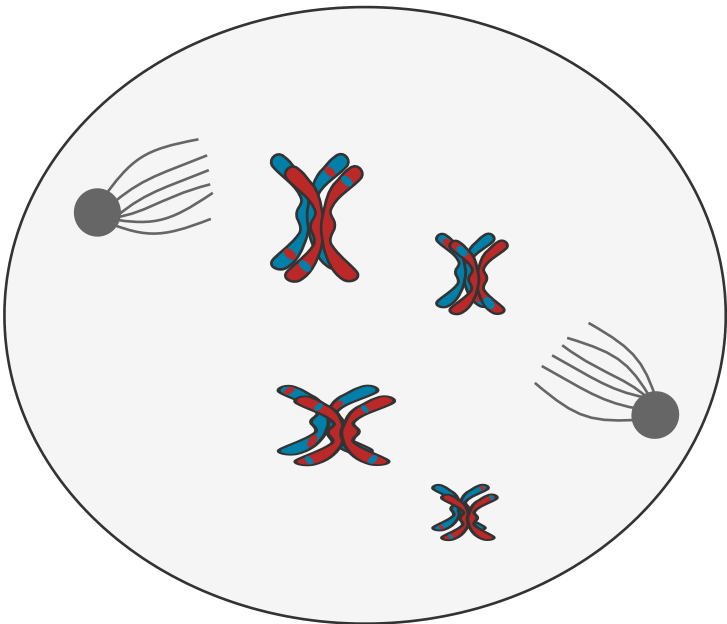
C



D



E



F

Put the stages above in the correct order, and match the name to each stage.

Order	Stage
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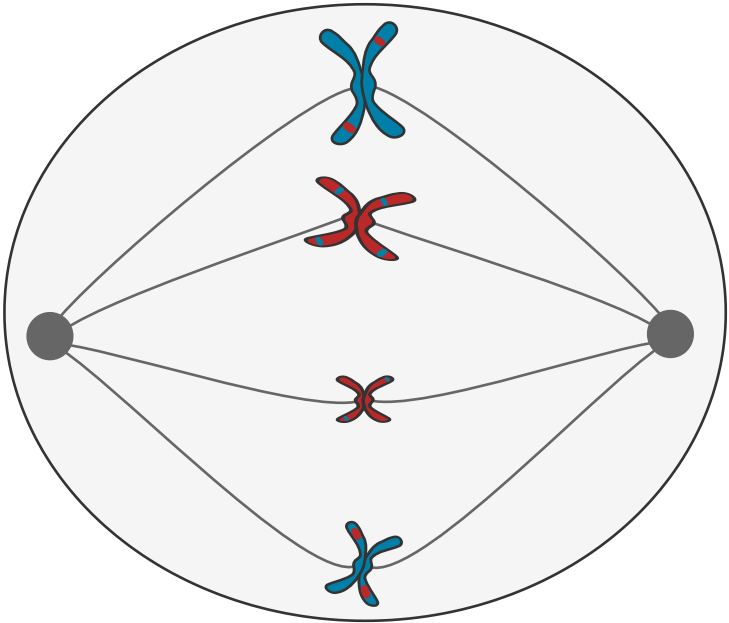
A	interphase
<div></div>	<div></div>
<div></div>	<div></div>
<div></div>	<div></div>
<div></div>	<div></div>
E	cytokinesis

Items:

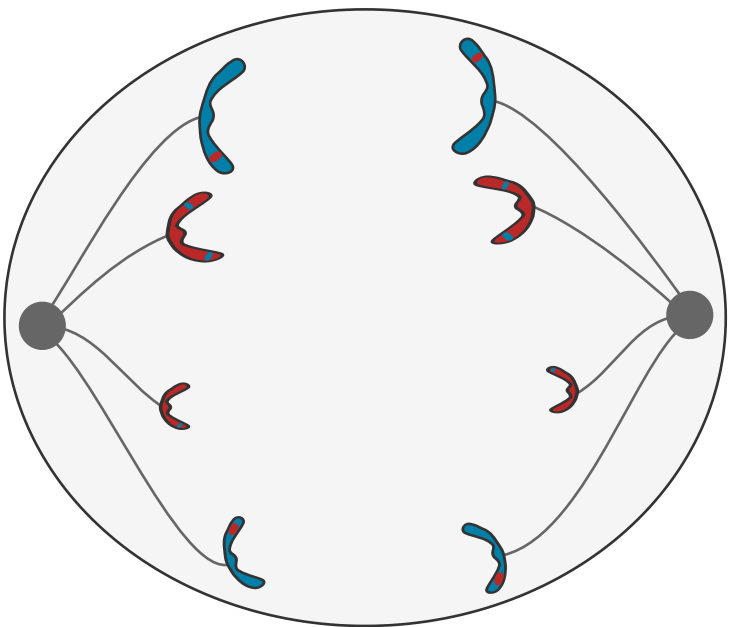
- B
- C
- D
- F
- anaphase I
- metaphase I
- prophase I
- telophase I
-

Part B    Meiosis II

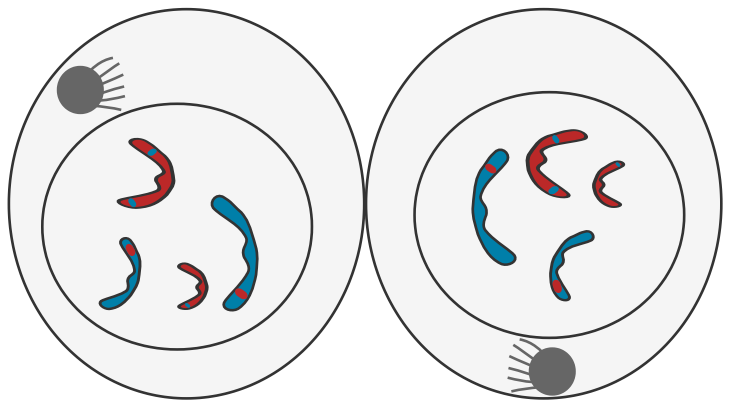
The images below represent different stages of meiosis II, for an organism with a diploid chromosome number of 8.



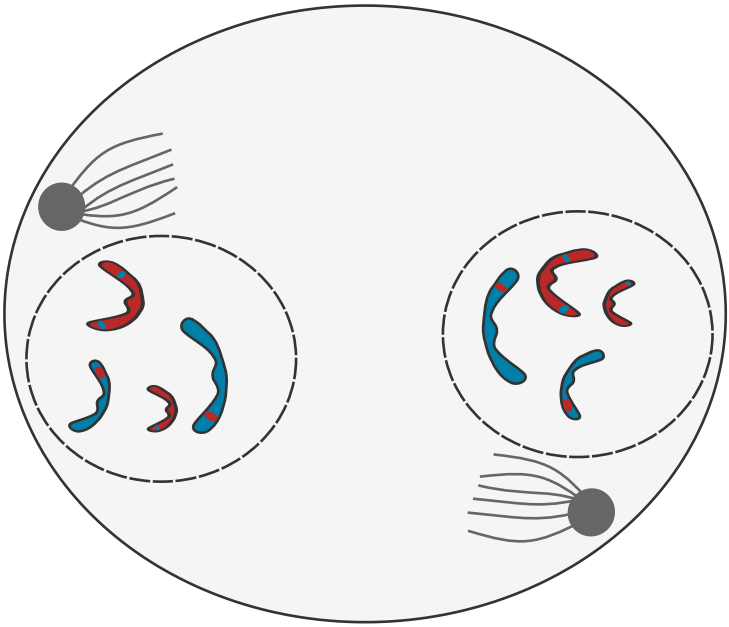
A



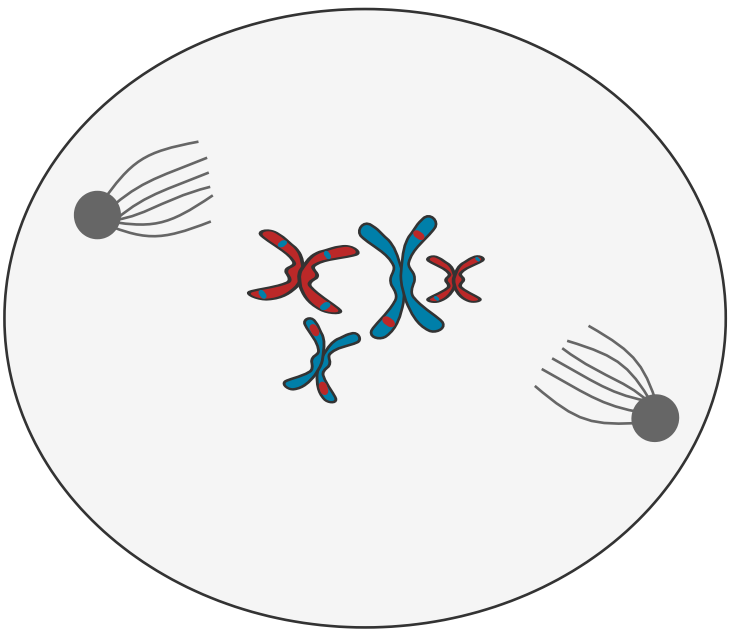
B



C



D



E

Put the stages above in the correct order, and match the name to each stage.

Order	Stage
<div></div>	<div></div>
<div></div>	<div></div>
<div></div>	<div></div>
<div></div>	<div></div>
C	cytokinesis

Items:

A

B

D

E

anaphase II

metaphase II

prophase II

telophase II



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# Recombination

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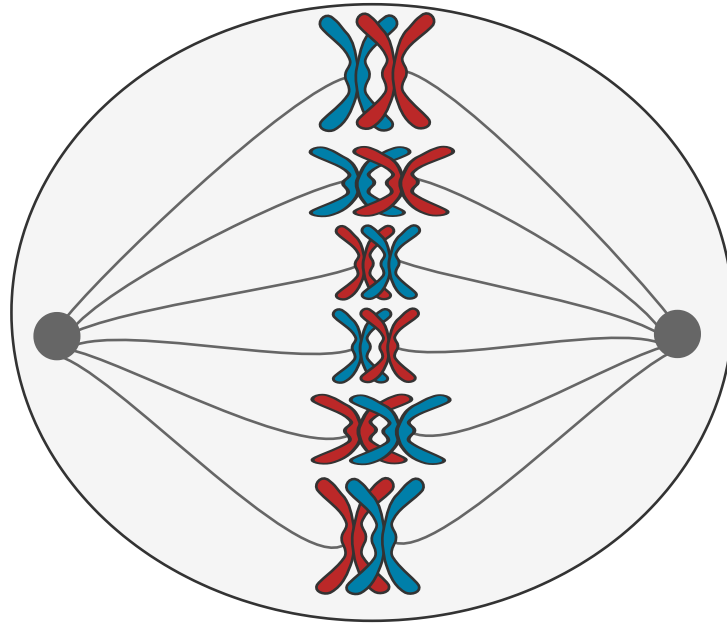
**A Level**



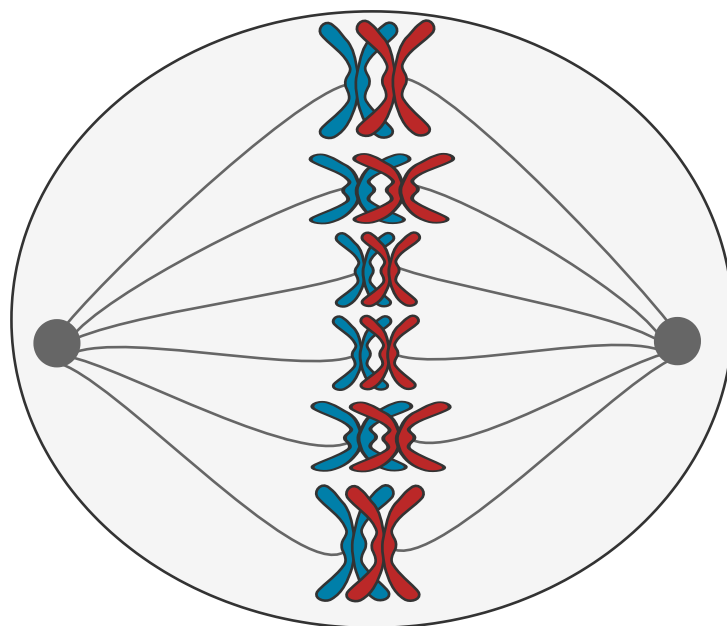
Recombination is the process of producing gametes with different allele combinations from those of the parents' gametes. This is the major cause of variation between parents and offspring (and among offspring). Recombination happens during meiosis in two main ways: independent assortment and crossing over.

## Part A Independent assortment

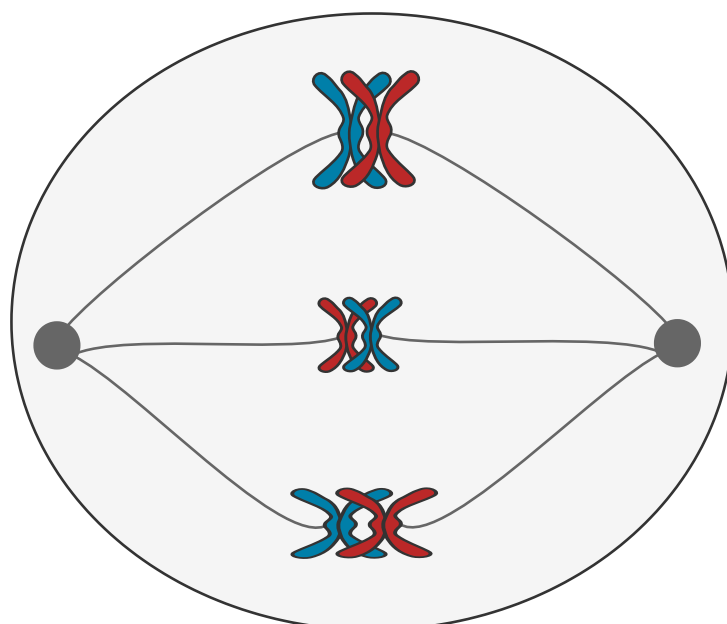
In the images below, blue chromosomes represent paternally-inherited chromosomes and red chromosomes represent maternally-inherited chromosomes.



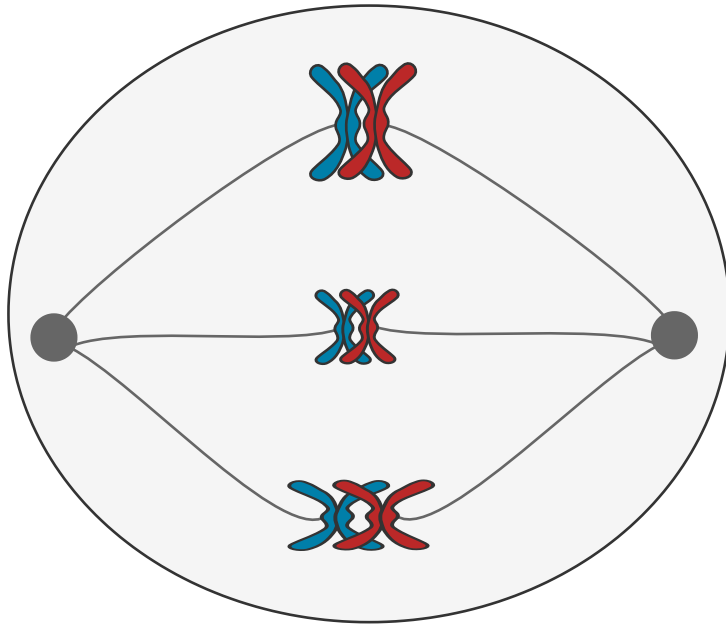
A



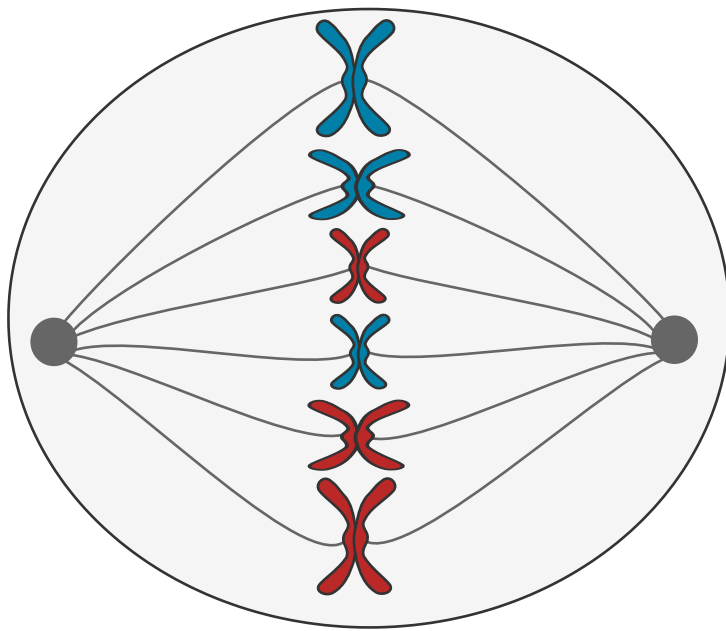
B



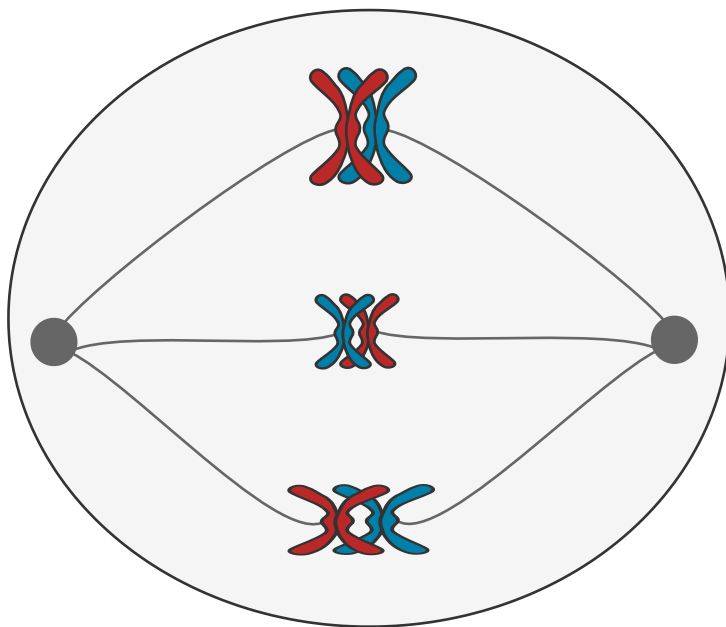
C



D



E



F

Which of the images above illustrate independent assortment during meiosis I of a cell with a diploid chromosome number of 6? Select all that apply.

☐ A

☐ B

☐ C

☐ D

☐ E

☐ F

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## Part B Crossing over

Independent assortment causes recombination of genes found on  chromosomes, whereas crossing over causes recombination of genes found on  chromosomes. Crossing over (swapping) of chromosome regions can happen when  chromosomes bind to each other (during  of meiosis) at points along the chromosomes called .

Items:

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## Part C Gamete possibilities

An individual is heterozygous for two genes (gene 1 and gene 2), which are located on different chromosomes (chromosome 1 and chromosome 2, respectively). The individual inherited allele **A** for gene 1 and allele **B** for gene 2 from its father, and inherited allele **a** for gene 1 and allele **b** for gene 2 from its mother. Its genotype for these two genes is **AaBb**.

Which of the following genotypes could be found in gametes produced by this individual?

- ☐ AB
  - ☐ ab
  - ☐ aB
  - ☐ Ab
- 

Which of the following genotypes could be found in gametes produced by this individual **if no recombination occurs?**

- ☐ AB
  - ☐ Ab
  - ☐ ab
  - ☐ aB
- 

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Gameboard:

**STEM SMART Biology Week 10**

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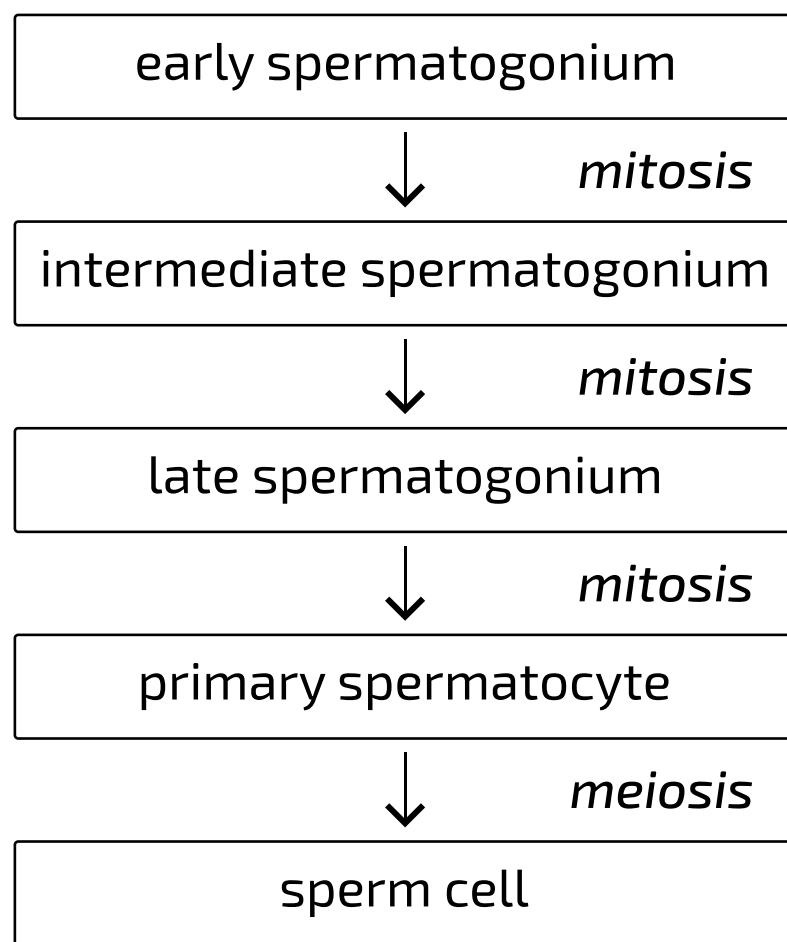


# Meiosis Mathematics

A Level



## Part A How many haploid cells?



**Figure 1:** The four steps in human sperm production. For each step, one complete division (i.e. one full round of the process) takes place.

Assuming no mutations and that all of the cells survive, what will be the maximum number of haploid cells originating from a single early spermatogonium (see Figure 1)?

Part B    Chromosome numbers

Humans have a diploid chromosome number of 46 (i.e.  $2n = 46$ ). Fill in the correct numbers and types of chromosomes present in a germ cell (reproductive cell) after each stage of meiosis, as well as the ploidy of each cell (haploid or diploid).

	after meiosis I	after meiosis II
number of chromosomes	<input type="text"/>	<input type="text"/>
number of chromatids per chromosome	<input type="text"/>	<input type="text"/>
ploidy (haploid or diploid)	<input type="text"/>	<input type="text"/>

Items:

- 23

46

92

1

2

3

4

haploid

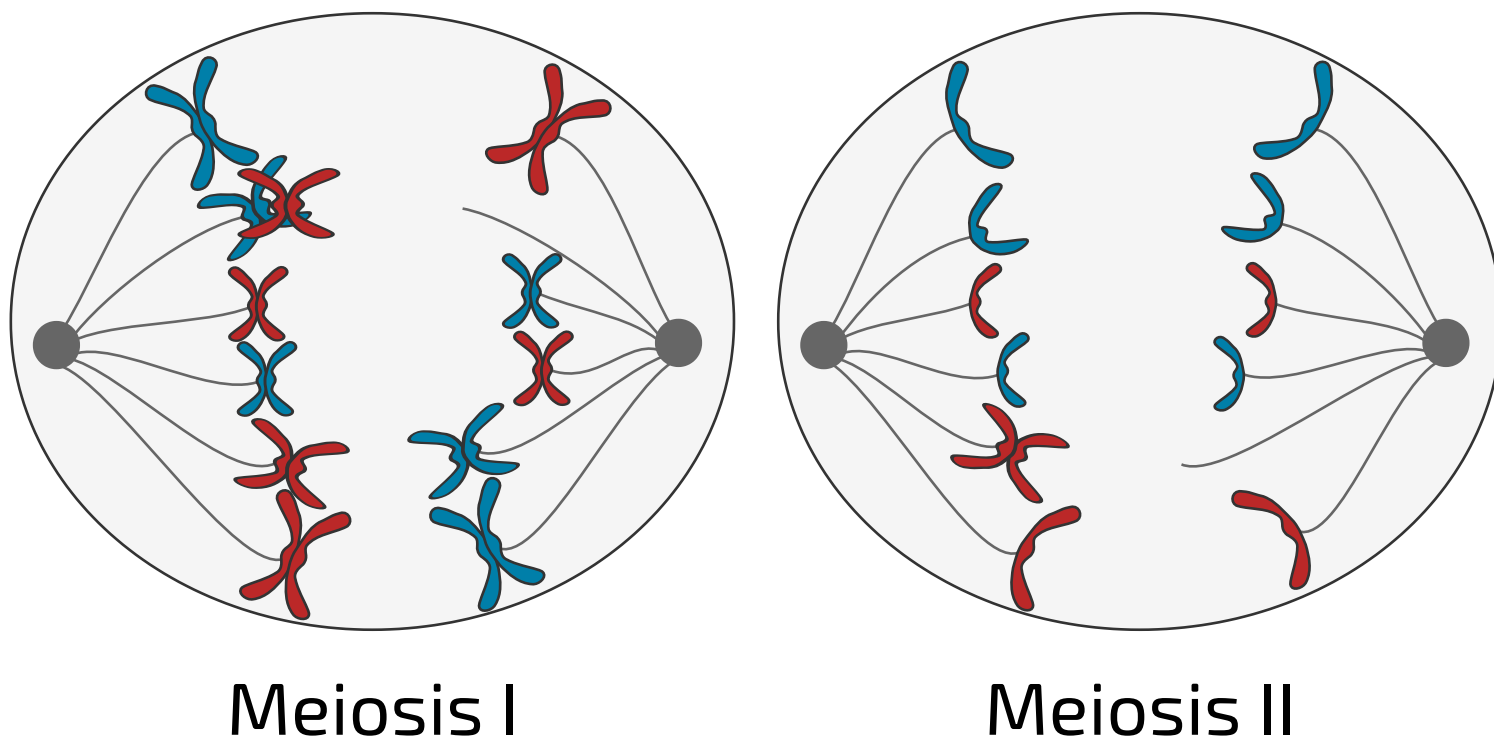
diploid

Part C    Chromosome combinations

During meiosis, independent assortment ensures that each gamete inherits a combination of some paternal chromosomes and some maternal chromosomes. How many possible combinations are there for a human gamete?

Question elements adapted with permission from NSAA 2018 Section 1 Q60

# Meiosis Mistakes



**Figure 1:** Two cells are shown, each from an organism with a diploid chromosome number of 12. The cell on the left is undergoing meiosis I, and the cell on the right is undergoing meiosis II. Both cells show something going wrong during their respective stages.

## Part A Meiosis stages

Which stages are shown in Figure 1?

- ☐ prophase I
- ☐ prophase II
- ☐ metaphase I
- ☐ metaphase II
- ☐ anaphase I
- ☐ anaphase II
- ☐ telophase I
- ☐ telophase II

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## Part B    Diagnosis

What is the name for what has gone wrong in Figure 1?

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## Part C    Consequences

Which of the following are conditions caused by what is shown in Figure 1?

- ☐ sickle cell anaemia
- ☐ monosomy (one less chromosome) e.g. Turner Syndrome (XO)
- ☐ trisomy (one extra chromosome) e.g. Down Syndrome
- ☐ haemophilia
- ☐ cystic fibrosis

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