Teacher Guidelines
Topic 2: Meiosis

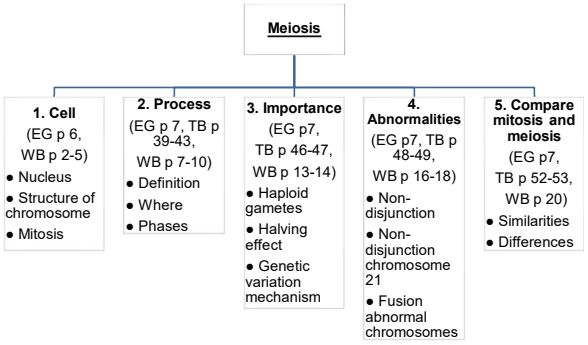
Meiosis

(1½ weeks, Paper 2: 21 marks)

This topic can be divided in the following subsections:

1. Introduction
2. Process
3. Importance
4. Abnormal meiosis
5. Comparing mitosis and meiosis

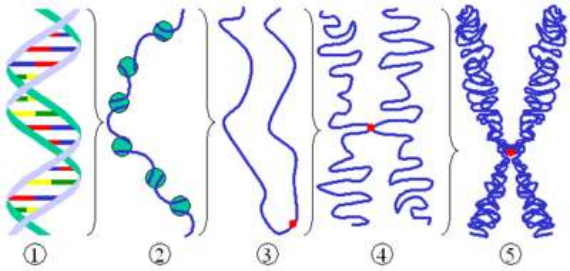
1



2

Meiosis

Introduction



3

Meiosis

Introduction

- Before cell divides, chromatin network contracts
- Becomes visible as individual chromosome (5)
- Each chromosome consist of:
  - DNA molecule that makes up genes
  - Wrapped around proteins

4

Meiosis

Species	*Parascaris equorum*	*Oryza sativa*	*Homo sapiens*	*Pan troglodytes*	*Canis familiaris*
Chromosome #	4	24	46	48	78
Common Name	Roundworm	Rice	Human	Chimpanzee	Dog

5

Meiosis

- During DNA replication:
  - Single stranded chromosomes
  - Becomes double stranded
  - All daughter cells contain same hereditary information as parent cell

6

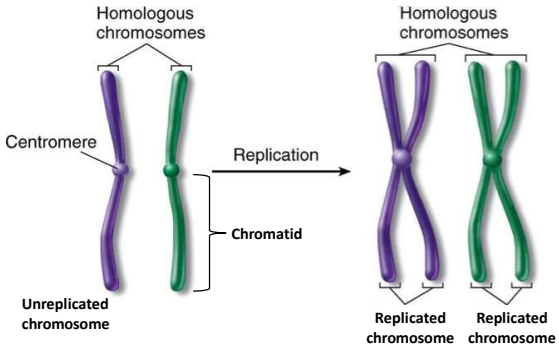
Teacher Guidelines
Topic 2: Meiosis

Meiosis

- Centromere
  - The point holding two chromatids together in a chromosome
- Replicated chromosomes:
  - Joined by single centromere
  - Separated during cell division to become individual chromosomes
- Homologous chromatid:
  - Two joined chromosome with the same function

7

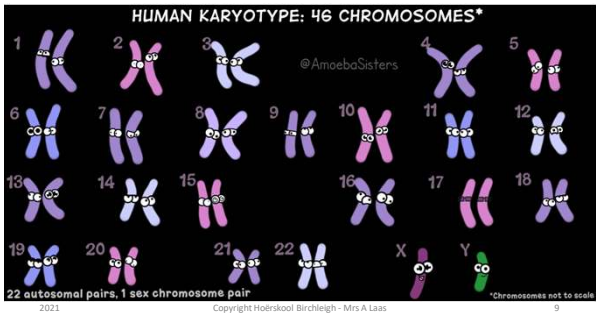
Meiosis



8

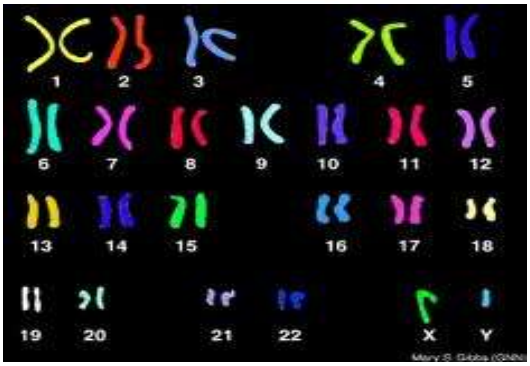
Meiosis

- Karyotype:
  - Number and appearance of chromosomes in the nucleus



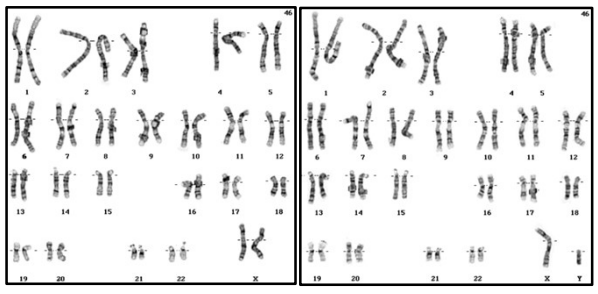
9

Meiosis



10

Meiosis



11

Meiosis

Differentiate between:

- Diploid (2n):
  - Two sets of complete paired chromosomes (full set)
- Haploid (n):
  - Single set of unpaired chromosomes
- Sex cell = Gametes
- Body cell = Somatic cell
- Sex chromosomes = Gonosomes (1 pair)
- Body chromosomes = Autosomes (22 pairs)

12

Teacher Guidelines
Topic 2: Meiosis

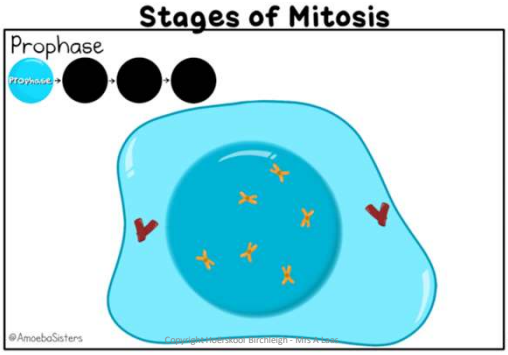
Meiosis

Complete **Self-Activity 1** on page 4 of the Grade 12 Life Sciences Workbook.

13

Meiosis

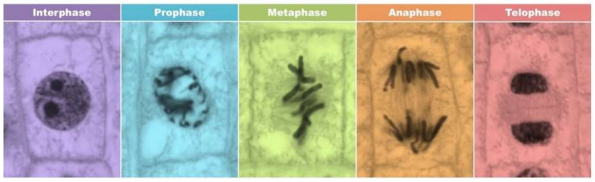
Mitosis



14

Meiosis

Mitosis



15

Meiosis

Complete **Self-Activity 2** on page 6 of the Graded 12 Life Sciences Workbook.

16

Meiosis

2. Meiosis

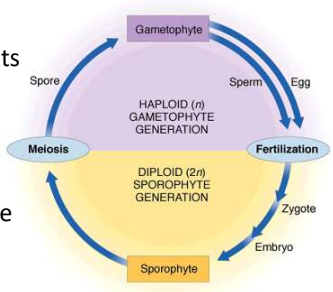
- Definition:
  - Double nuclear division that reduces the chromosome number to the haploid (n) condition
  - the number of chromosomes is halved.

17

Meiosis

Where does it take place…

- Plants:
  - The gametes of plants are called spores.
  - Anther to produce pollen grains in the male
  - Ovary to produce the ovule in the female plants.



18

Teacher Guidelines
Topic 2: Meiosis

Meiosis

- Animals:
  - In gonads (Reproductive organs).
  - Testes (males) and ovaries (females).
  - The cells produced by meiosis are called gametes (reproductive cells) and the process known as gametogenesis.
  - Male gametes are called spermatozoa (sperm cells), they are produced by the process known as spermatogenesis.
  - Female gametes are called ova (egg cell / ovum), they are produced by the process known as oogenesis.

19

Meiosis

- Important Terms:
  - Random segregation:
    - ✓ The separation of the two alleles of a gene into different gametes, caused by separation of homologous chromosomes during meiosis
  - Allele:
    - ✓ One of the possible forms of a given gene, the alleles of a particular gene occupy the same positions (loci) on homologous chromosome

20

Meiosis

Complete **Self-Activity 3** on page 8 of the Grade 12 Life Sciences Workbook.

Marking guideline Self-Activity 3

- 1.1 D ✓
- 1.2 A ✓
- 1.3 B ✓
- 1.4 E ✓
- 1.5 C ✓

21

Meiosis

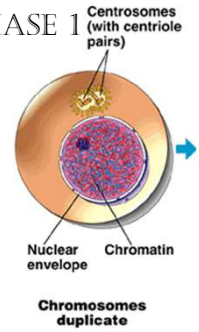
- Process:
  - Occurs in 2 phases
  - Meiosis 1:
    - ✓ Nucleus of parent cell divides
    - ✓ Forms 2 cells with half of the number of chromosomes
    - ✓ Each cell has different genetic material.
  - Meiosis 2:
    - ✓ Each of the two daughter cells divide
    - ✓ Forms 2 cells each
    - ✓ End results is 4 cells

22

Meiosis

Meiosis 1

- INTERPHASE 1



23

Meiosis

Meiosis 1

- INTERPHASE
  - (Preparation for Meiosis 1)
  - DNA replicates (takes place before Meiosis) helps to double genetic material so that it can be shared by the new cells arising from cell division
  - Single-stranded chromosomes become double stranded
  - Each chromosome will now consist of 2 chromatids joined by centromere

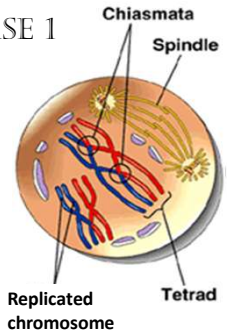
24

Teacher Guidelines
Topic 2: Meiosis

Meiosis

Meiosis 1

- PROPHASE 1



25

Meiosis

Meiosis 1

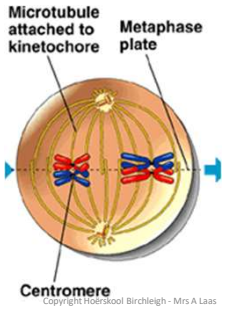
- PROPHASE 1
  - Chromosomes become visible
  - Nuclear membrane disappears
  - Spindle fibers form from the centrosome
  - Homologous chromosomes pair up and exchange segments of chromosomes during crossing over, seen as chiasmata

26

Meiosis

Meiosis 1

- METAPHASE 1



27

Meiosis

Meiosis 1

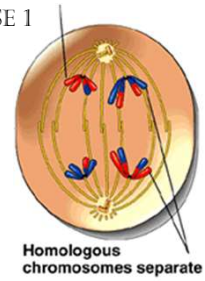
- METAPHASE 1
  - Homologous chromosomes line up randomly at equator
  - Spindle fibers attaches to centromeres

28

Meiosis

Meiosis 1

- ANAPHASE 1



29

Meiosis

Meiosis 1

- ANAPHASE 1
  - Spindle fibers attaches to centromeres
  - Spindle fibers contract and pull one chromosome of each **pair** towards opposite poles

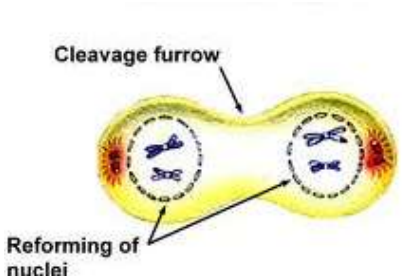
30

Teacher Guidelines
Topic 2: Meiosis

Meiosis

Meiosis 1

- TELOPHASE 1



31

Meiosis

Meiosis 1

- TELOPHASE 1
  - Chromosomes reach the poles and nuclear membranes reform
  - Cytokinesis occurs
  - Two new cells are formed
    - genetically different
    - half of the chromosome number

32

Meiosis

Meiosis 2

- PROPHASE 2

33

Meiosis

Meiosis 2

- PROPHASE 2
  - Chromosomes (with two chromatids) are visible
  - Nuclear membrane disappears
  - Spindle fibers visible

NOTE:

No replication

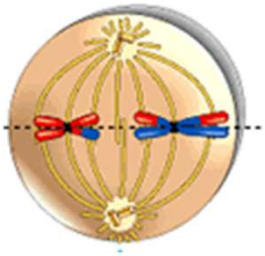
Chromosomes still replicated from Interphase 1.

34

Meiosis

Meiosis 2

- METAPHASE 2



35

Meiosis

Meiosis 2

- METAPHASE 2
  - Chromosomes line up randomly at equator
  - Spindle fibers attach to centromere

36

Teacher Guidelines
Topic 2: Meiosis

Meiosis

Meiosis 2

- ANAPHASE 2

37

Meiosis

Meiosis 2

- ANAPHASE 2
  - Spindle fibers shorten
  - Each centromere divides as chromatids are pulled to opposite poles

38

Meiosis

Meiosis 2

- TELOPHASE 2

39

Meiosis

Meiosis 2

- TELOPHASE 2
  - Separation of chromatids
  - Daughter chromosomes are at poles
  - Nuclear membrane re-forms
  - Cytokinesis occurs

40

Meiosis

Complete **Group-Activity 1** on page 11 of the Grade 12 Life Sciences Workbook.

41

Meiosis

Complete **Self-Activity 4** on page 12 of the Grade 12 Life Sciences Workbook.

42

Teacher Guidelines
Topic 2: Meiosis

Meiosis

3. Importance of Meiosis

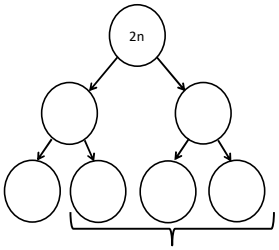
- Meiosis is biologically significant because it:
  - Results in the formation of gametes in a process called gametogenesis
  - Reduces the number of chromosomes by half to produce haploid gametes

2021 Copyright Hoërskool Birchleigh - Mrs A Laas 43

43

Meiosis

- Cells inside a follicle in an ovary:

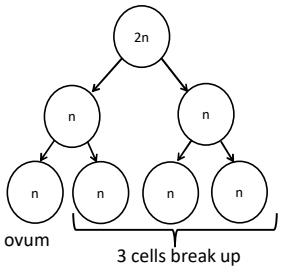


2021 Copyright Hoërskool Birchleigh - Mrs A Laas 44

44

Meiosis

- Cells inside a follicle in an ovary:

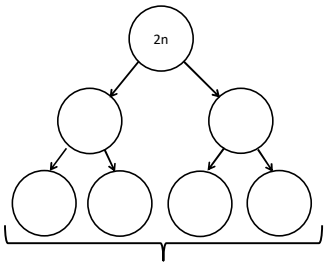


2021 Copyright Hoërskool Birchleigh - Mrs A Laas 45

45

Meiosis

- Germinal epithelial cells in testes:

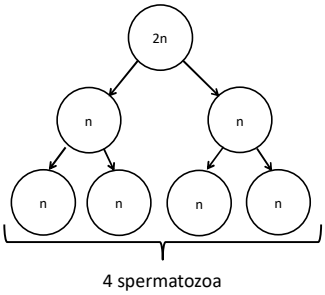


2021 Copyright Hoërskool Birchleigh - Mrs A Laas 46

46

Meiosis

- Germinal epithelial cells in testes:



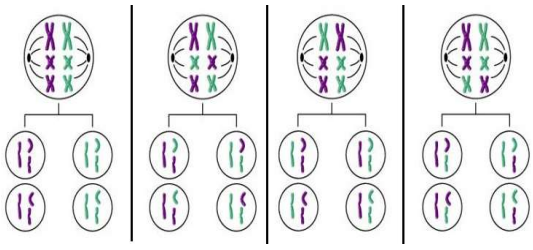
2021 Copyright Hoërskool Birchleigh - Mrs A Laas 47

47

Meiosis

Genetic variation

- Random segregation:



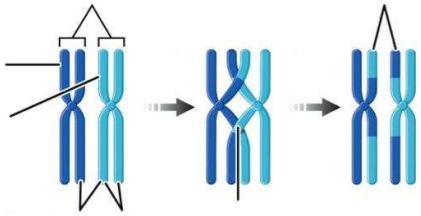
2021 Copyright Hoërskool Birchleigh - Mrs A Laas 48

48

Teacher Guidelines
Topic 2: Meiosis

Meiosis

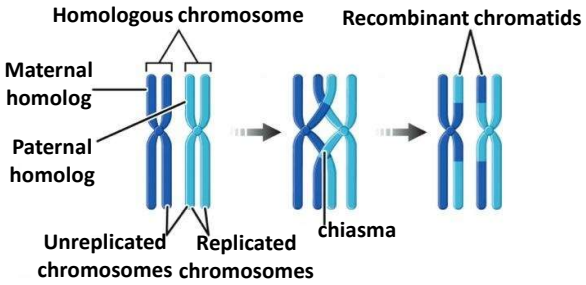
- Crossing over:



49

Meiosis

- Crossing over:



50

Meiosis

Complete **Self-Activity 5** on page 15 & 16 of the Grade 12 Life Sciences Workbook.

51

Meiosis

4. Abnormal Meiosis

- Non-disjunction:
  - Chromosome of a chromosomal pair not separating during meiosis
  - One pair of chromosomes fails to separate
  - One cell receives two copies of the chromosome
  - Other cell does not receive any
  - Occurs during separation of the homologous chromosomes during Anaphase 1 OR when replicated chromosome separate during Anaphase 2

52

Meiosis

- Consequences:

  1. Anaploidy
- Mutation in which the number of chromosomes changes
- E.g. 47 chromosomes in Down's syndrome.
  - It is caused by an extra chromosome 21.
  - So the zygote has 3 chromosomes on 21 instead of 2.
  - Down syndrome is therefore also called Trisomy 21.

53

Meiosis

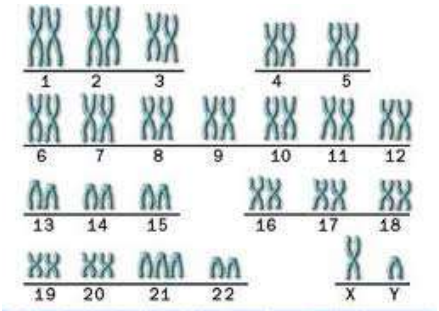
- During meiosis I (anaphase I) the chromosome pair may not separate, therefore one gamete will have an extra chromosome, while the other will have no copies of chromosome 21.
- The same can also occur in meiosis II (anaphase II) the chromatids may not separate.

54

Teacher Guidelines
Topic 2: Meiosis

Meiosis

- Down's syndrome:



55

Meiosis

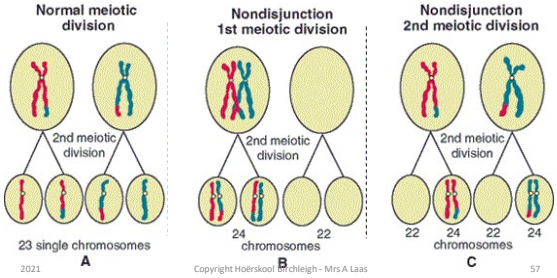
2. Polyploidy

- Organism has complete extra set of chromosomes
- E.g. 4n or 8n
- Benefits:
- Forms seedless varieties of fruit such as watermelons/bananas/some apples
- Polyploidy cells are bigger, therefore these plants would have larger flowers, fruits and storage organs.
- Infertile plants become fertile e.g. wheat
- Plants may be more healthy because they are resistant to diseases.

56

Meiosis

- Complete **Self-Activity 6** on page 17 of the Grade 12 Life Sciences Workbook.
- Self-Activity 6



57

Meiosis

- Trisomy
  - Occurs when an individual has three of the same chromosomes in a cell instead of two.
  - Individuals born with this conditions suffer from a variety of abnormal and physical and mental characteristics.
- Leads to Trisomy 21
  - Occurs as a result of chromosome 21 not separating during metaphase 1
  - There will be a gamete that contains two number 21 chromosomes and not only one
  - Should this gamete (ovum) be fertilised by a normal sperm cell, the resulting zygote will contain 47 chromosomes instead of the normal 46.

58

Meiosis

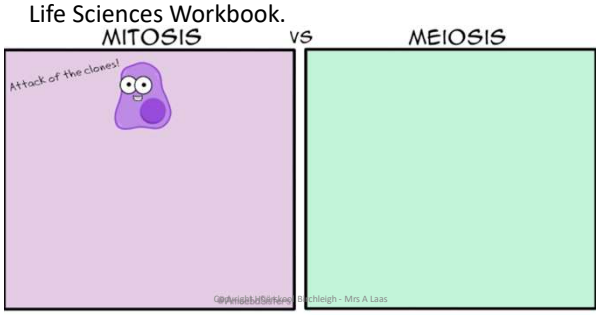
Complete **Self-Activity 7** on page 18 & 19 of the Grade 12 Life Sciences Workbook.

59

Meiosis

5. Comparison of mitosis and meiosis

- Complete Self-Activity 8 on page 20 of the Grade 12 Life Sciences Workbook.



60

Teacher Guidelines
Topic 2: Meiosis

Meiosis

Complete **Self-Activity 9** on page 21 & 22 of the Grade 12 Life Sciences Workbook.

61

Meiosis

☑ END OF TOPIC 2

62