3.3 MEIOSIS

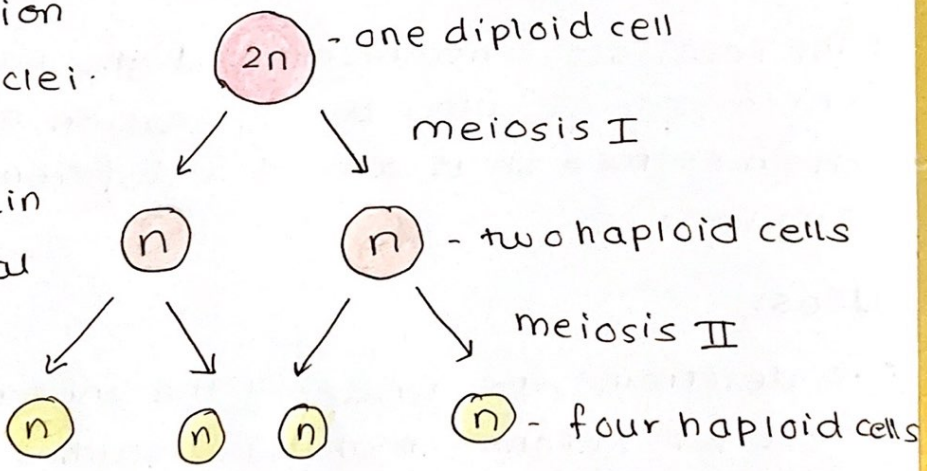
MEIOSIS IN OUTLINE

Meiosis (reduction division)

- It is the process by which gametes are made in the reproductive organs.
- In meiosis, the nucleus divides twice.

The first division produces 2 nuclei.

These divide again to give a total of 4 nuclei



In meiosis I the homologus pair of chromosomes are separated.

In meiosis II sister chromatids separate.

MEIOSIS AND SEXUAL LIFE CYCLE

In asexual lifecycle the offspring is genetically identical to the parent cell (have the same chromosomes due to mitosis).

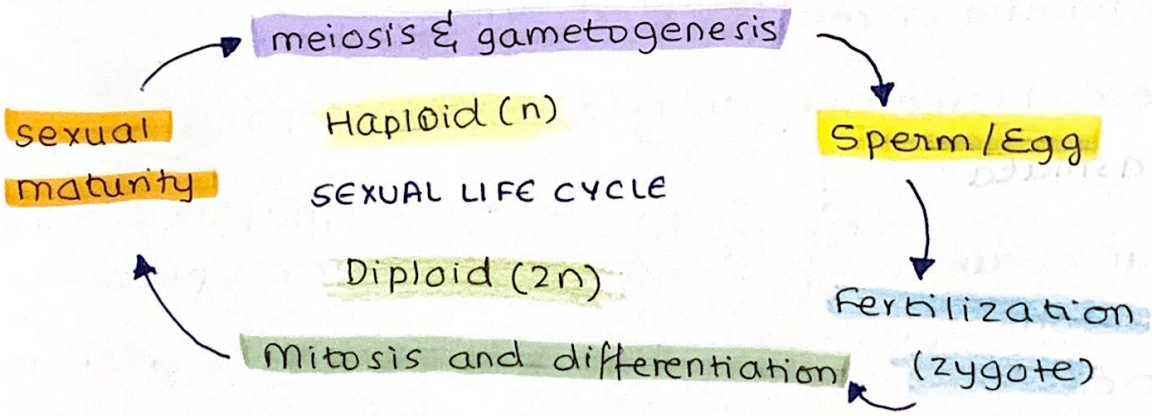
In sexual life cycle, there is genetic diversity as the chromosomes are different in the parent and the offspring.

most sexually reproducing organisms are diploid.

- They have two copies of every chromosome (maternal/ paternal).

Fertilization:

- It is the union of gametes from two different parents.
- It doubles the chromosome number.
- It results in the formation of a diploid zygote that grows via mitosis.

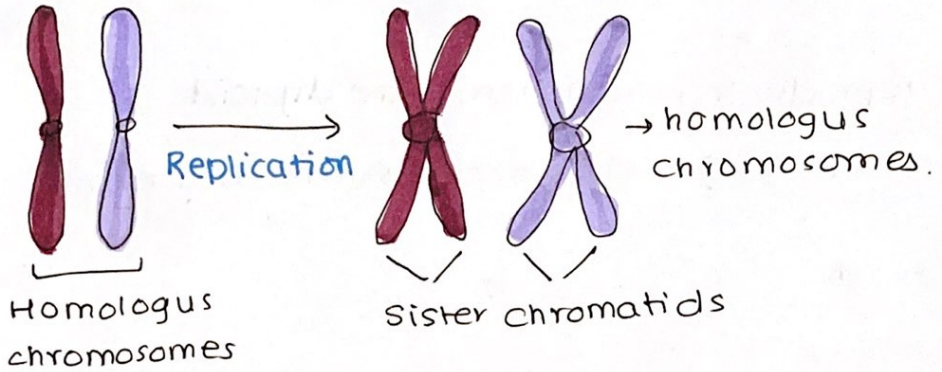


REPLICATION OF DNA BEFORE MEIOSIS

DNA is replicated before meiosis so that all chromosomes consist of 2 sister chromatids.

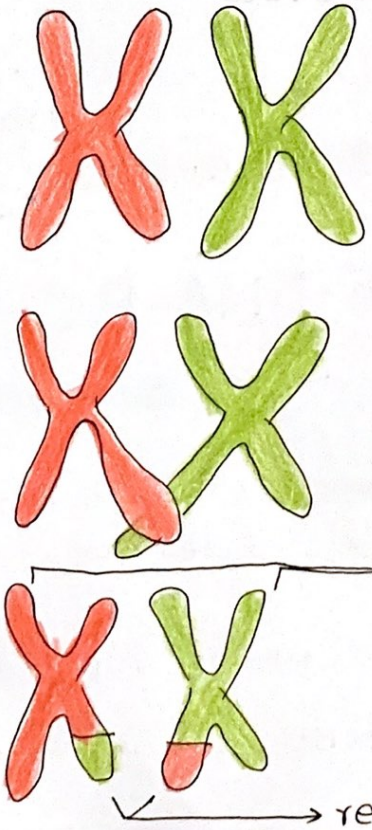
- chromosomes shorten due to supercoiling.
- Each chromosome consists of 2 sister chromatids.

- The sister chromatids are held by a centromere.
- They are separated during meiosis II.



BIVALENT FORMATION AND CROSSING OVER

- A pair of homologus chromosomes is a bivalent.
  This pairing process is called synapsis.
  → These chromosomes are held together at points called chiasmata.
- It can occur at random positions.
- If this occurs, then all 4 haploid cells will be genetically distinct.



- After synapsis, crossing over takes place.
- A junction is created where one chromatid in each of the chromosomes breaks and rejoins the other chromatid.

MEIOSIS STAGES

Meiosis I

The first meiotic division is a reduction division in which homologous chromosomes are separated.

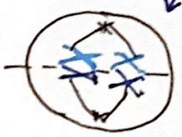
Prophase I:

- chromosomes condense, nuclear membrane dissolves, formation of bivalents & crossing over occurs.

↓ 2n=8

Metaphase I:

- Spindle fibres from opposing centrosomes connect to the bivalents & align them along the equator of the cell.



Anaphase I:

- Spindle fibres contract and split the bivalent
- Homologus chromosomes move to the opposite ends of the cell.

Telophase I:

- chromosomes uncoil, cell divides to form 2 haploid daughter cells.

Meiosis II

The second division separates sister chromatid

Prophase II:

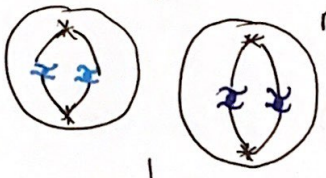
- chromosomes condense, nuclear membrane dissolves, centrosomes move to the opposite poles.

Metaphase II:

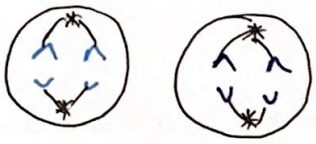
- Spindles from opposing centrosomes attach to chromosomes & align them along the equator.

n = 2

Phraphase II



Metaphase II



Anaphase II

Spindle fibres contract & separate the sister chromatides, moving them to the opposite ends of the cell.

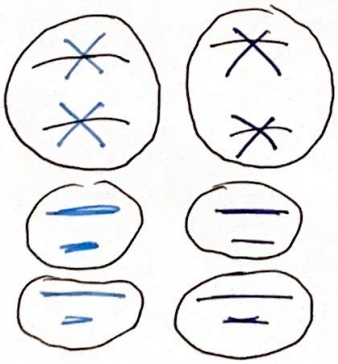
n = 2 n = 2

Telophase II

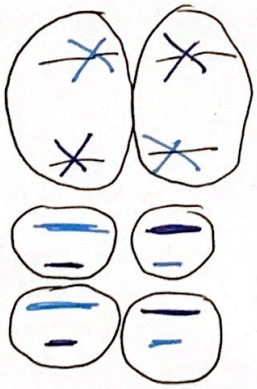
chromatids decondense, nuclear membrane reforms, cells divide to form 4 haploid cells.

RANDOM ASSORTMENT

- In metaphase I the orientation of bivalents is random and doesn't influence the orientation of any others.



Possibility 1



Possibility 2

- It leads to genetic variation.
- Gamete combinations $= 2^n$ (n = haploid no.)

GENETIC VARIATION

The advantage of meiotic division & sexual reproduction is that it promotes genetic variation in offsprings.

3 main sources of variation

- Crossing over
- Random Assortment of chromosomes
- Random fusion of gametes.

1. Crossing over

- It allows the linked genes to be reshuffled to produce new combinations.
- It increases the number of allele combinations that can be generated by meiosis.

2. Random assortment of chromosomes

3. Random fusion of gametes

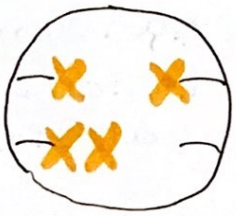
- The fusion of 2 haploid gametes results in the formation of a diploid zygote.
- It allows alleles from 2 different individuals to be combined in one new individual.

∴ Random fertilization can result in genetic variation.

- Identical twins are formed after fertilization by fission of the zygote into 2 separate cells.

NON-DISJUNCTION

It refers to the chromosomes failing to separate correctly, resulting in gametes with 1 extra or 1 missing chromosome (aneuploidy).



Faliure to separate in Anaphase I

In Meiosis I

gametes

n+1 n+1 n-1 n-1

(all get affected)

Faliure to separate in Anaphase II

In meiosis II

gametes

n ++ n-1 n n

(2 get affected)

Conditions:

Down syndrome
(trisomy 21)

Edwards syndrome
(trisomy 18)