Lesson 02: TRANSMISSION OF GENETIC CHARACTERS IN EUKARYOTES

Introduction:

The transmission, within a living species or cell line, of characteristics from one generation to the next.

- **Segregation Law**

• Each individual has two factors (called genes today) for each trait.

• Factors separate during gametogenesis. (gamete ploidy level)

• Fertilization gives each new individual two factors again.

Transmission of characteristics from one generation of individuals to the next occurs through **cell division.**

Cell division is the process by which the cell reproduces itself, and it is the basis for the perpetuation of life. So the purpose of cell division is to:

- creates a generation identical to the parent in unicellular organisms
- is responsible for growth in multicellular organisms.
- is responsible for development in multicellular organisms.
- is responsible for repair in multicellular organisms.

The process of cell division is complex since the cell requires exact duplication and equal division of the DNA that contains the cell's genetic programming (the genome).

1- The cycle cellular

There duration of a cycle cellular very variable following the kind cellular : some cells to actively divide, while others can go a very long time without dividing.
whatever the cell type, we find the same characteristic phases :

- ***The interphase*** maybe cut out in three phases.
- **The G1 phase** during which the amount of DNA per cell remains constant and can be described as simple (quantity = q). During this stage, the cell uses its genetic information, can grow and carry out its functions.
- **There phase S (S as in synthesis**) is marked by a progressive doubling of the quantity DNA. It is therefore during the S phase, which lasts several hours, that

DNA replication takes place.

- **Phase G2** , the cell prepares for the mitosis. The quantity of DNA during this phase is stable, it is double that of the G1 phase (quantity = 2q).

- ***Mitosis*** is the period during which the chromosomes, clearly visible, are equally distributed between two daughter cells: it lasts one hour.

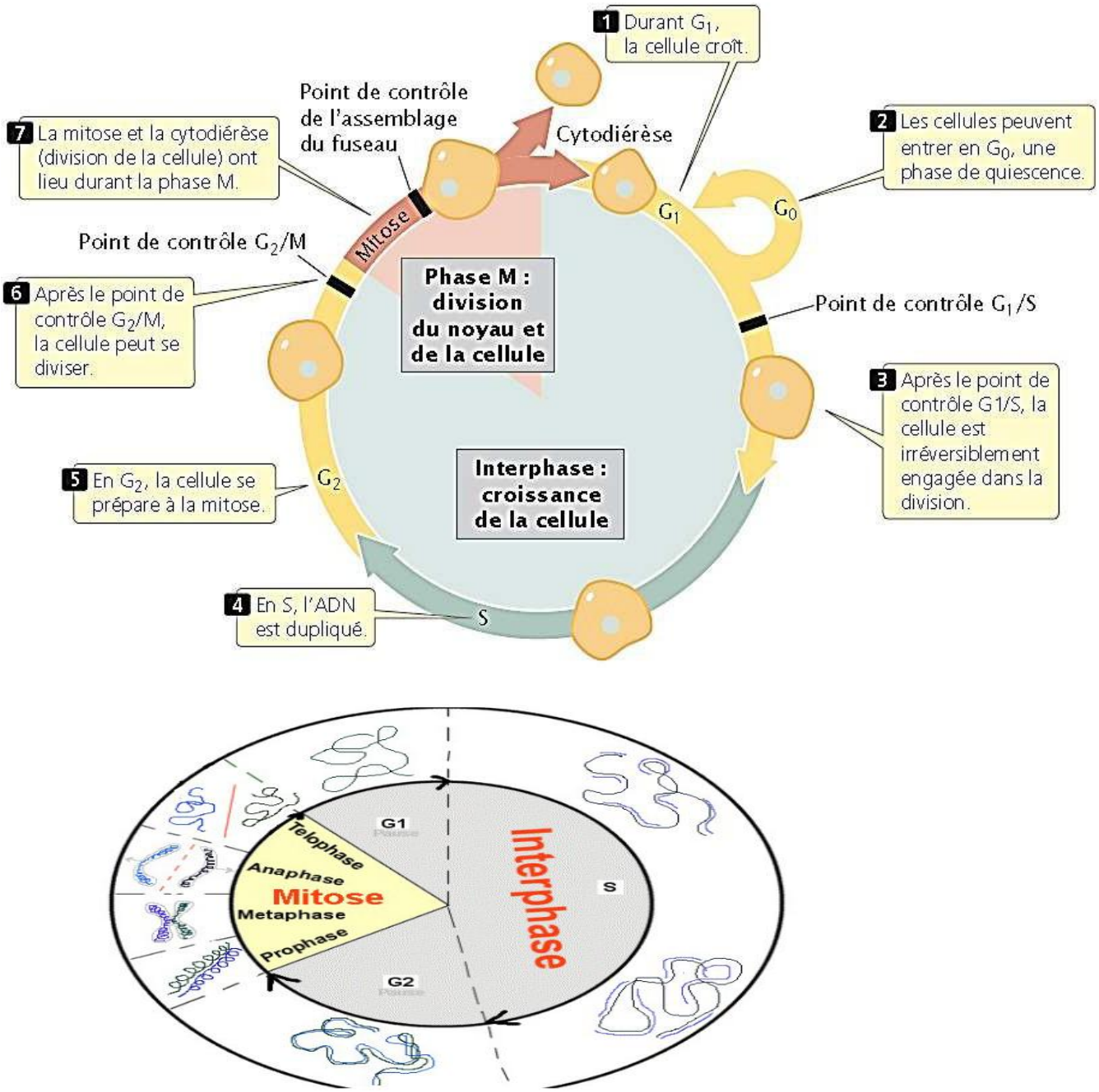


Figure: THE different phases of cycle cellular (cell somatic)

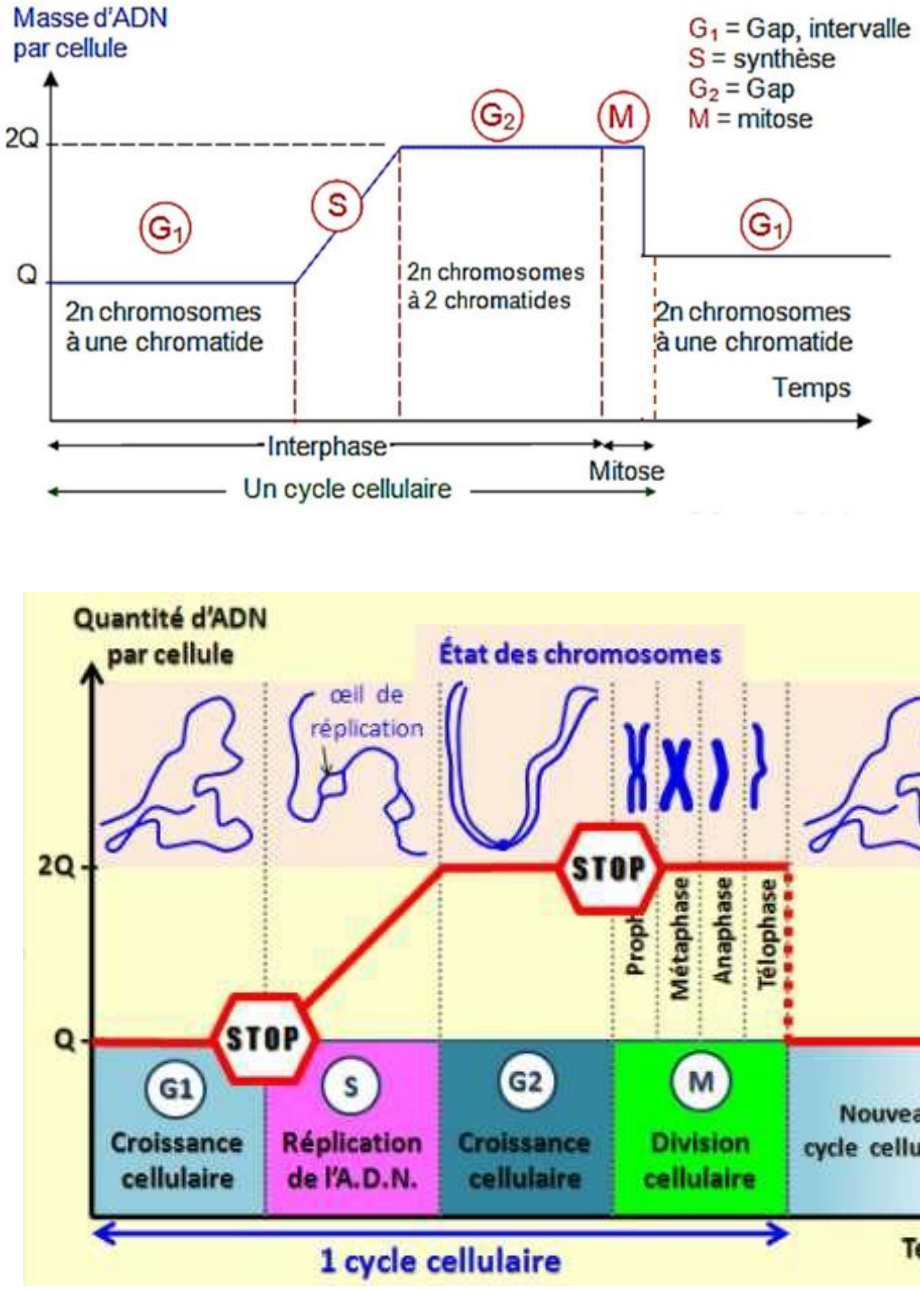


Figure : Balance sheet of the cycle cellular (cell somatic)

2- Mitosis

All somatic cells of multicellular organisms derive from the same original mother cell, **the fertilized egg** or **zygote** , through a succession of cell divisions called mitosis.

Mitosis has a two functions :

- First of all of create a copy exact of each chromosome.
- Secondly, to distribute, during cell division of the mother cell into two

daughter cells, an identical set of chromosomes in each of them.

Mitosis is composed of 4 phases: prophase, metaphase, anaphase and telophase.

- **Prophase:** During this phase, chromosomes condense, the nuclear membrane and nucleolus begin to fragment.
- **Prometaphase :** corresponds to the period during which the chromosomes get into position
- **Metaphase:** The mitotic spindle (microtubule network) appears in the form of fine filaments. The chromosomes are arranged in the same line on the equatorial plate thanks to the action of the fibers, but there is no pairing between homologous chromosomes.
- **Anaphase:** Chromosomes divide at their centromeres. Thus, the two chromatids of each chromosome migrate to opposite poles due to a shortening of the kinetochore fibers .
- **Telophase:** During this phase, the chromosomes are divided into two identical batches, each at one pole of the cell. The chromosomes begin to decondense. The spindle disappears, the nuclear envelope reforms, and the cytoplasm divides by a process called cytokinesis , forming two daughter cells.

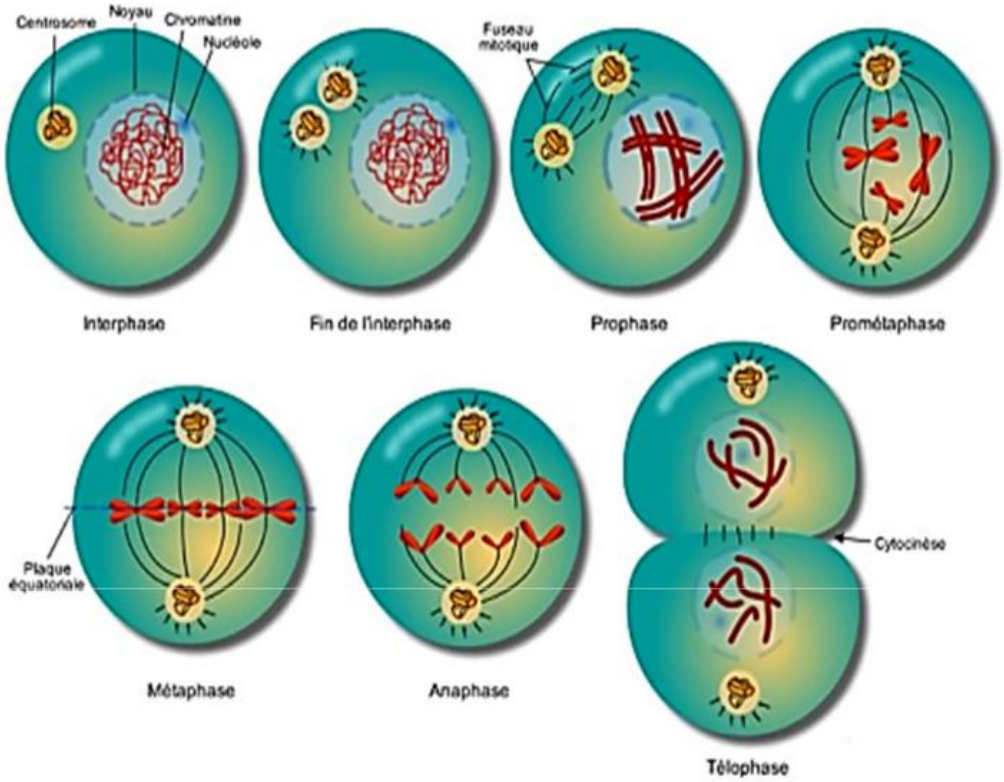
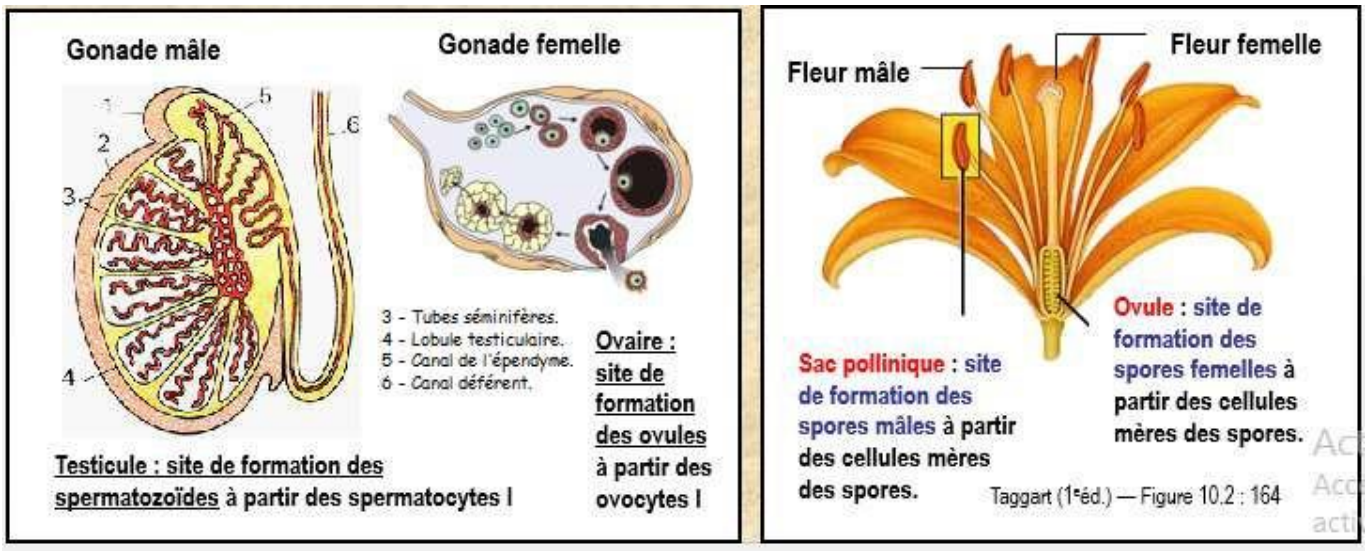


Figure: The different stages of mitos

3. Meiosis

There meiosis to product In the organs breeders (gonads And flowers) And split a cell mother in gametes in animals and in spores in plants:



At the house of animals at	**the plants**
La méiose a lieu dans les gonades mâles (testicules) et gonades femelles (ovaires). Les cellules produites sont les **gamètes (spermatozoïde et ovule)** ou cellules sexuelles ou cellules reproductrices.	La méiose a lieu dans les **fleurs** mâle (étamine) et femelle (pistil). Les cellules produites sont les **spores**. Elles se développeront par mitose et produiront les gamètes mâles et femelles.

It is the transformation of a mother cell (via a double division) into four daughter cells which contain only half of the chromosomes of the mother cell.

Each daughter cell receives one homologue from each pair that was originally in the parent cell. Meiosis introduces genetic variability into the offspring because they are the result of the reassembly of the genetic half-set of two parents.

The role of meiosis :

- Produce gametes (sooner or later) which fertilize and ensure the reproduction of the species.
- Maintain the constancy of the genetic pool from generation to generation by allowing genetic reduction, then restored by fertilization.
- Produce a infinity of combinations genetics In THE gametes in order to to generate many genetically diverse descendants.

- **The stages of meiosis**

Meiosis involves two successive divisions (meiosis I and meiosis II) which lead to the production of 4 haploid cells with n chromosomes.

1. **Meiosis I (the first meiotic division):**

It is a reductional division because it reduces the number of chromosomes in the initial cell.

1.1 Prophase I: Prophase of meiosis I is subdivided into 5 stages: leptotene, zygotene , pachytene, diplotene and diakinesis .

1. **Leptotene (fine filament stage):** During this stage, chromatin condenses into very long, thin strands.
2. **Zygotene (joined filament stage)** : At this stage, homologous chromosomes appear as partially paired structures. They are still very elongated.
3. **Pachytene (thick filament stage):** At this stage, synapsis (pairing of homologous chromosomes) is complete. Each pair of paired homologous chromosomes is called a bivalent (bivalent is a tetrad with 4 chromatids). It is at this stage that genetic exchanges by crossing-over between the non-sister chromatids of each bivalent will begin.
4. **Diplotene (double filament stage):** Homologous chromosomes separate from each other (separation at the centromere), but remain attached at the chiasma (region where crossing-over has occurred).
5. **Diakinesis :** The chromosomes have reached their maximum degree of condensation, the nucleolus and nuclear membrane disappear, the chromatic spindle begins to form.

1.2. Metaphase I: During this phase, bivalents orient themselves randomly on the equatorial plane of the cell with their centromeres attached to the spindle.

1.3. Anaphase I: Homologous chromosomes separate and migrate to opposite poles. Each chromosome (made up of two sister chromatids) migrates separately.

1.4. Telophase I: Cytokinesis produces two haploid daughter cells from a diploid mother cell.

2. Meiosis II (second meiotic division):

The second division occurs after telophase. There is no DNA replication between the two divisions and each chromosome always contains two chromatids. Meiosis II is very similar to mitosis. It is an equational division.

2.1. Prophase II: The color spindle reforms.

2.2. Metaphase II: The individualized chromosomes are placed on the equatorial plate.

2.3. Anaphase II: The centromeres of each chromosome divide, allowing the migration of sister chromatids at opposite poles.

2.4. Telophase II: Telophase II cytokinesis divides each cell into two daughter cells.

Le cycle méiotique (Méiose I et Méiose II) permet donc d'obtenir 4 cellules filles haploïdes, à partir d'une cellule mère diploïde.

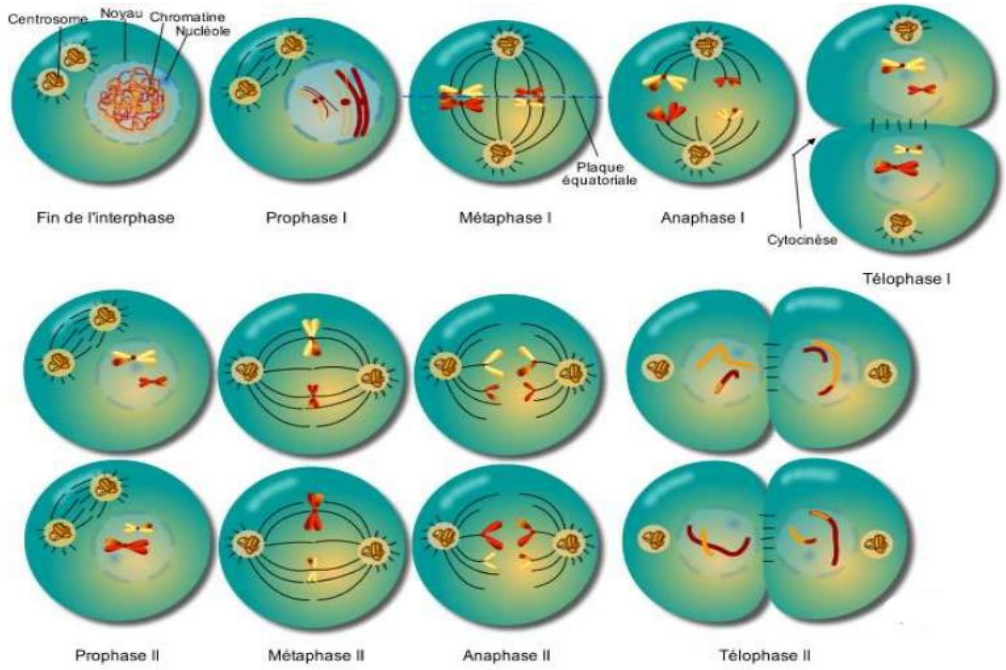


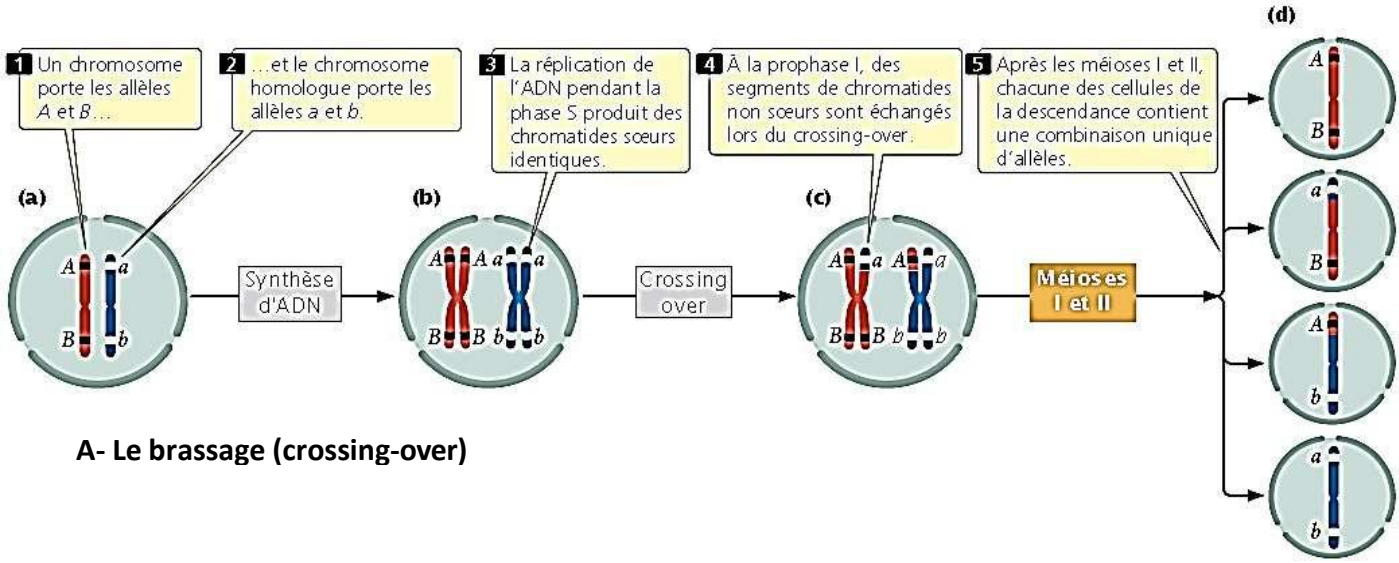
Figure: The different stages of Meiosis

- **Consequences of meiosis**

Meiosis product of there diversity genetic (many gametes different) via :

A- The enjambments : THE brewing (crossing-over), in **prophase 1** , they mix genes parental.

B- The assortments independents : there distribution random of the chromosomes in **metaphase 1.**



A- Le brassage (crossing-over)

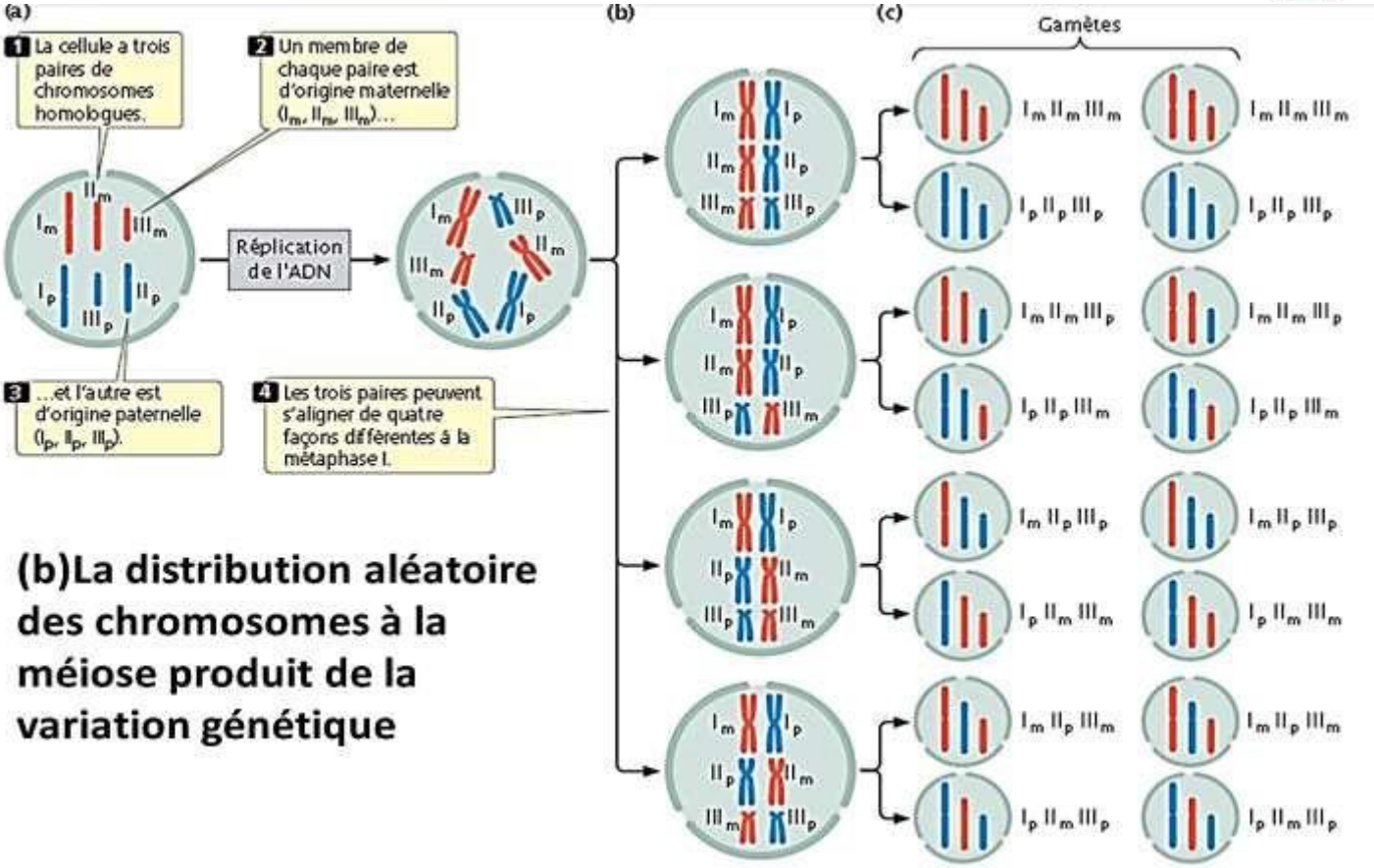


Figure : Consequence of there meiosis (has : Brewing and b : distribution random of the chromosomes) Copyright © 2011 by WH Freeman and Company (Cunin , 2012)

4. Comparison between mitosis and meiosis

Painting 1 : Differences features between mitosis and meiosis

Mitosis	Meiosis
A division equational separated chromatids sisters .	The first step (meiosis 1) is a reduction division that separates homologous chromosomes has there first anaphase . THE chromatid sisters separate during there equational division (meiosis2) of the second anaphase
A division by cycle, either a cytoplasmic division (cytokinesis) by chromosome division equational	Two divisions per cycle, or two cytoplasmic divisions , one following reductional division , And the other has there following of there division equational .
THE chromosomes do not enter not in synapsis; Not of training of chiasm .	THE chromosomes enter in synapsis And form of the chiasmas .
Not exchange genetic between THE chromosomes counterparts.	Of the exchanges genetics produce between THE counterparts .
Two cells girls are produced by cycle .	Four cells (gametes Or spores) are produced by cycle.
THE content genetic of the cells girls East identical has the one of the mother cell .	THE content genetic of the cells girls East different of the one of the mother cell .
THE number of chromosome of the daughter cells East identical to that of the cell mother .	THE number of chromosome of the cells girls East reduced has there half by report to that of there cell mother .
The cells issues of mitosis are generally capable of to undergo others mitoses	THE cells issues of there meiosis to can not to undergo a other meiosis but can to undergo a mitosis .
To product in the most cells somatic	To product only In THE cells specialized of there line germinal .
Begin At stadium zygote And continues throughout the life of the organism .	Occurs in organisms mature superiors . product at the house of THE zygotes of there most of the algae and mushrooms.