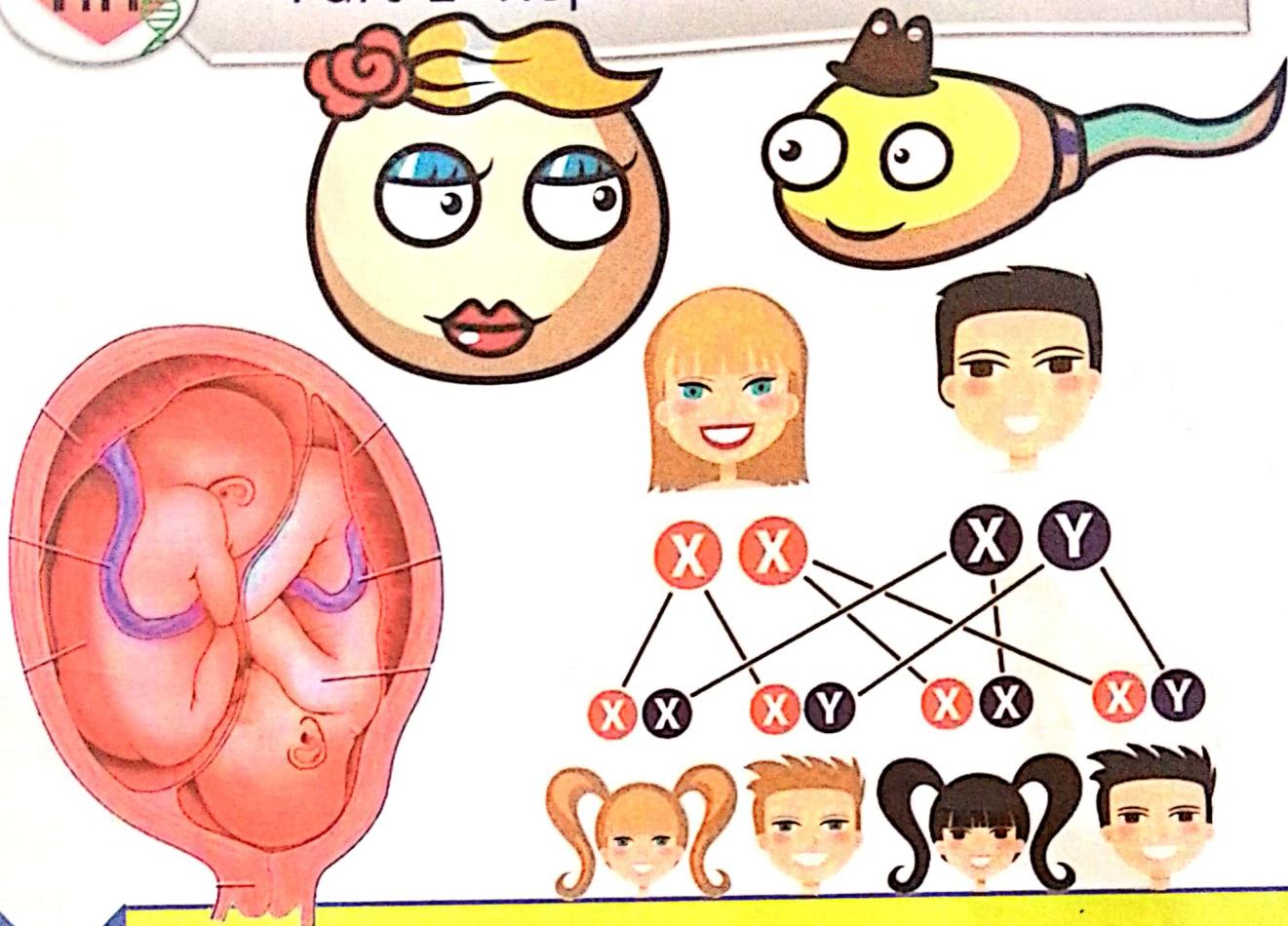




# Part-1- Reproduction & Genetics



P.16

- Ch-1-Basic Mechanisms of Sexual Reproduction

P.57

- Ch-2-Transmission of Genes & Genetic Recombination

P.87

- Ch-3- Genetic Variation & Polymorphism

P.112

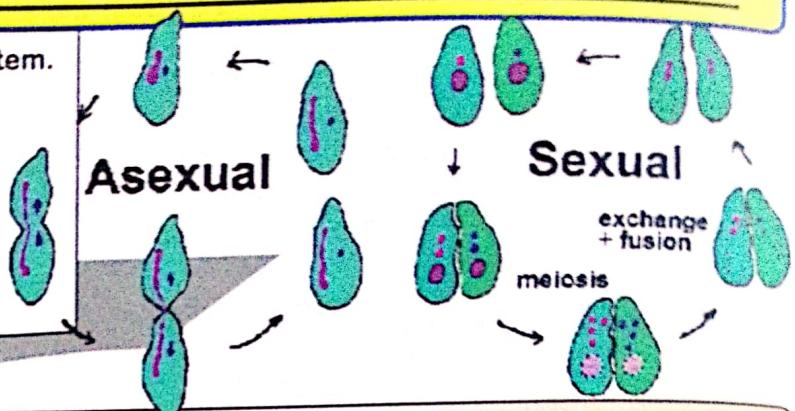
- Ch-5- Human Genetics

**189 Exercises**

34 Official Exercises + 107 Solved + 48 Practice Alone

# • Basic Mechanisms of Sexual Reproduction

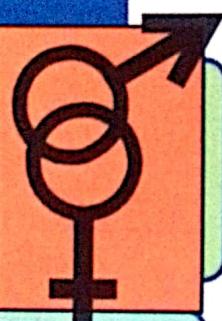
- 1- Male and female reproductive system.
- 2- Diploid and haploid cells.
- 3- Meiosis.
- 4- Spermatogenesis.
- 5- Oogenesis.
- 6- Fertilization



**Reproduction:** It is necessary for the continuity of life. Any species whose reproduction capacity is not efficient will extinct (It prevents the eradication of species).

## Sexual Reproduction

It needs the presence of two different sexes (male & female) of the same species. Part-1-



It is characterized by:  
Diversity / polymorphism / heterogeneity  
(Meiosis, random fertilization & mutation)

## Asexual Reproduction

It doesn't need the participation of two different sexes. One parent is capable of direct cell division (fission) to produce new progeny cells (daughter cells)

Excluded from LS

It is characterized by :  
Uniformity or homogeneity  
(identical reproduction - Clone)

### Male repro sys + Female repro sys

Ch-1

Somatic cell Ch-2 Somatic cell

Ch-4 Meiosis in the gonads Ch-5

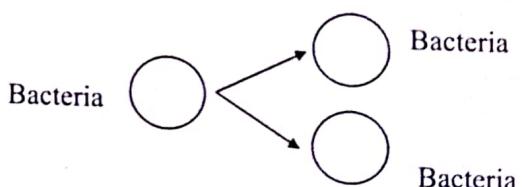
Sperm Gamete

Ovum Gamete

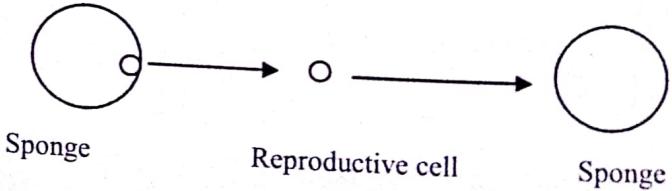
Zygote with unique genetic information

This is Part I of our book

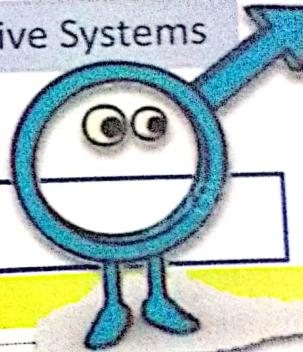
Ex.1: Bacteria divide by mitosis:



Ex.2: Sponges reproduce by fission:



## 1. Male Reproductive System



The journey of sperm cells from birth to their release. (1 to 7)

**4. Accessory glands:**  
(Prostate gland, seminal vesicles & Cowper's glands)

They provide spermatozoa with the needed nutritive substances (fructose).  
(spermatozoa 10% + nutritive fluid 90% = semen).

**5. Urethra / Uro-genital tube**

- a- It is a tube-like structure found within the penis.
- b- The sperm ducts are united and pour their secretion (urine + semen) in the urethra.

**3. Sperm ducts (vas deferens):**

They are responsible for the transportation / conduction of the spermatozoa from epididymis towards penis.

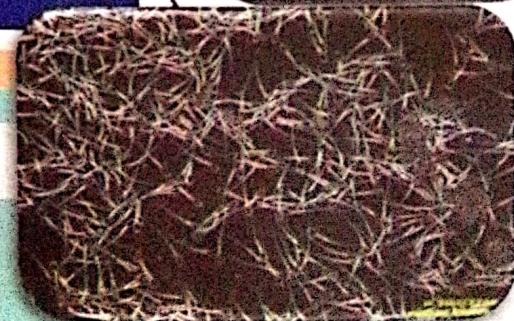
**2. Epididymis:**

- a- It's a much coiled tubule.
- b- It's responsible for storage and maturation of spermatozoa to be able to survive, motile, & fertilize.

**1. Testes / Testicles (male gonads):**

- a- They are the site of spermatogenesis [Doc-4]:  
(Production of male gametes: sperms by meiosis) [Doc-3].

- b- They are responsible for the secretion of the male sexual hormone testosterone: (it's responsible for the appearance & development of the male primary & secondary sexual characteristics or traits).



A single sperm has 37.5MB of DNA information in it. That means a normal ejaculation represents a data transfer of around 1,587GB in about 3 seconds... and you thought 4G was fast.

## 2. Female Reproductive System



### 1. Ovaries (female gonads):

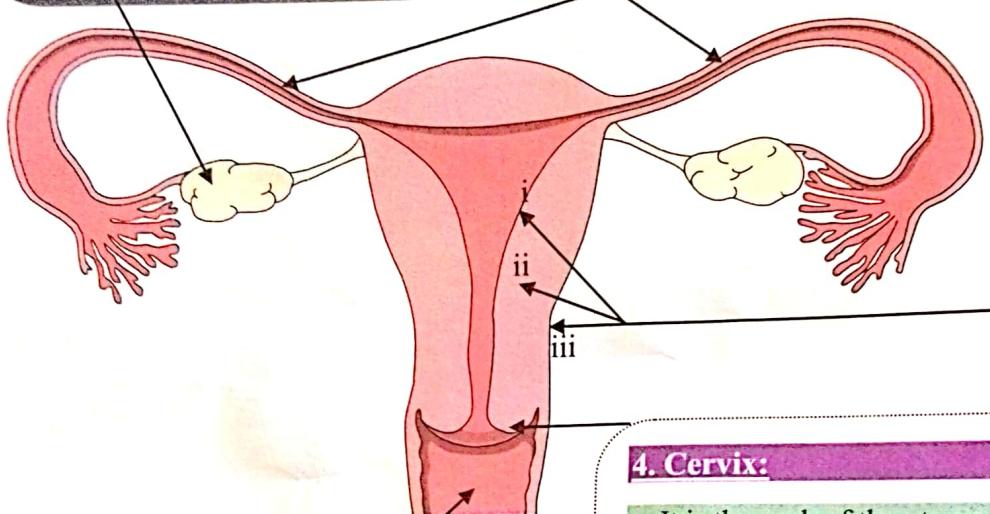
- a- They are the site of Oogenesis (production of Ova) [Doc-5] by meiosis [Doc-2]
- b- They are responsible for the secretion of the female sexual hormones: (estrogen & progesterone). They are responsible for the appearance and growth of the female sexual characteristics). [Ch-15 & 16].

### 2. Oviducts / fallopian tubes:

- a- It is the site of fertilization[Doc-6]
- b-They are responsible for conduction of the ova & later on the embryo (in case of fertilization) from the ovary towards the uterus.

### 3. Uterus / Womb:

- a- It's the house of the embryo.
- b- It consists of 3 successive layers:
  - i. **Endometrium:** It is the internal richly-vascularized layer that supplies the implanted embryo with the needed nutritive substances during pregnancy.
  - ii. **Myometrium:** It is a middle muscular layer which contract to push the baby outside during delivery or labor
  - iii. **Serous layer:** It is the external layer that protects & supports the uterus.



### 5. Vagina:

- a- It's a tube-like structure.
- b- It is the female copulatory organ.
- c- Its outer part (External genitalia) called: Vulva.

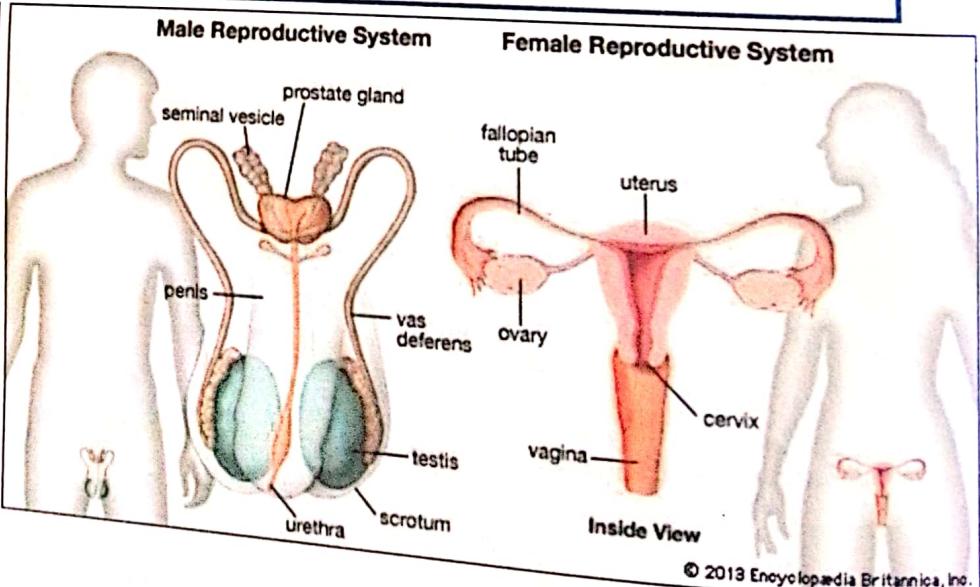
### 4. Cervix:

- a- It is the neck of the uterus
- b- It possesses mucus glands or cervical glands.

It is responsible for the secretion of mucus. During ovulation, the cervical mucus is thin, watery, smooth & loose, which facilitates the penetration of the spermatozoa through the cervix, while outside ovulation period the cervical mucus is thick, viscous, sticky and dense, that prevents the passage of spermatozoa.

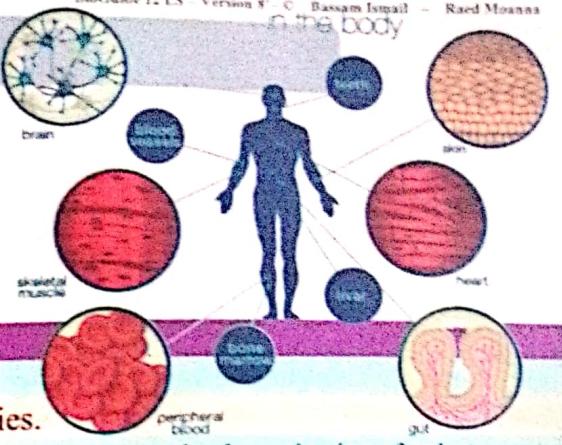
### 3. General Comparative table + Summing up figure :

Comparison	1. Male reproductive system	2. Female reproductive system
Gonads	Testes	Ovaries
Genital duct	Epididymis vasa differentia & Urethra	Oviduct + Uterus + Cervix
Copulatory organ	Penis	Vagina
Mode of action	Spermatogenesis is a continuous process, but it decreases with age (it starts from puberty till old age).	Oogenesis is a cyclic process starting from embryonic life then pause at birth until puberty where it starts again till menopause & interrupted during pregnancy.

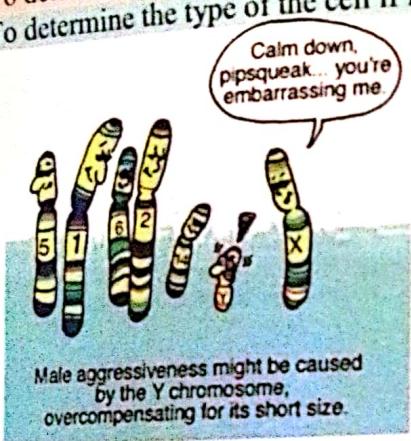


**1- Definition of a karyotype:**

It is the process of counting and arrangement of chromosomes depending on certain criteria.

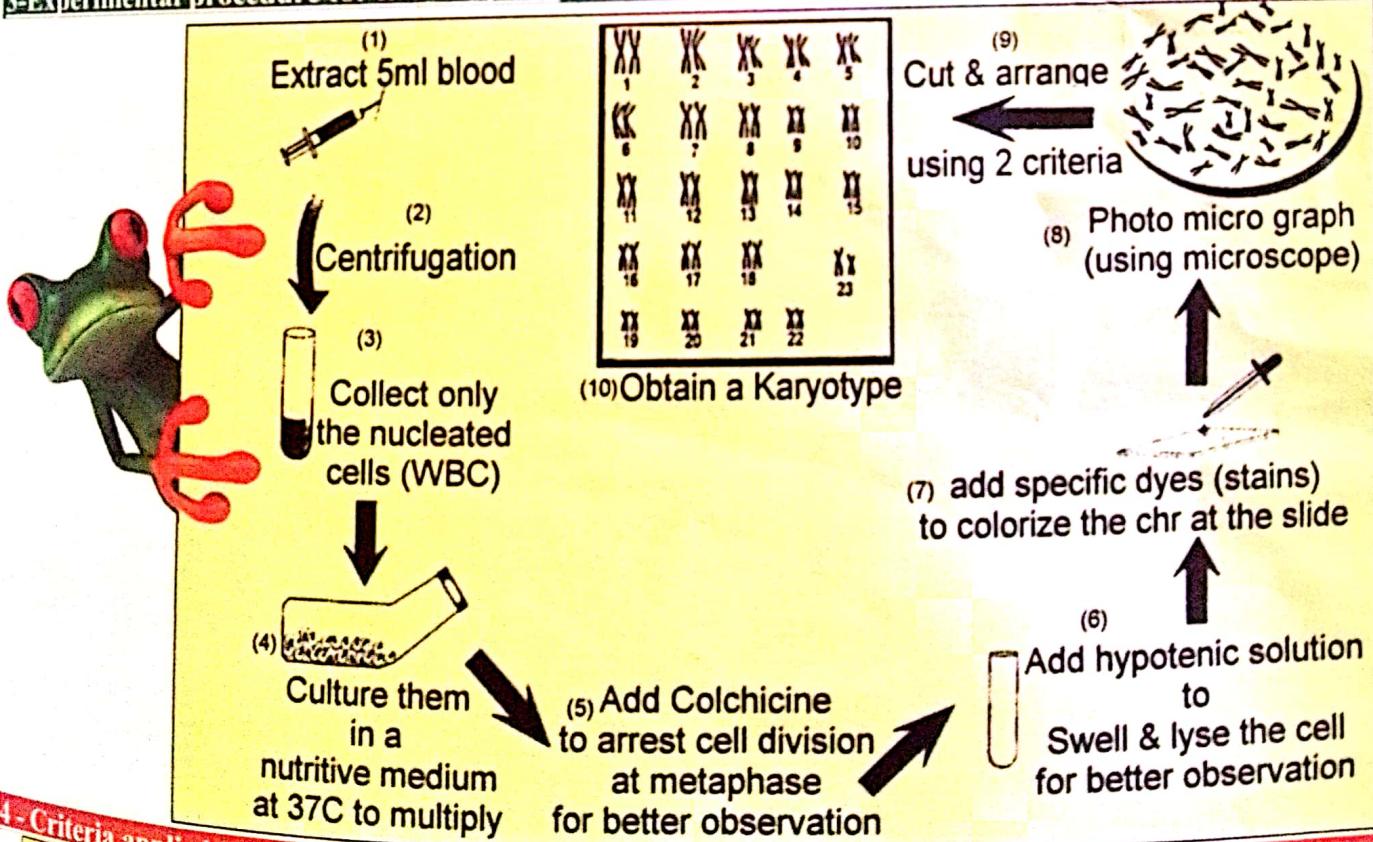
**2- Objectives of karyotyping:**

- i. To determine the sex of an organism / fetus.
- ii. To determine the characteristic number of chrs of each species. [Some species have the same number of chrs but they are completely different because the determination of traits or phenotypes is independent of the number of chrs but it depends on the genes (alleles) carried by these chrs].
- iii. To determine if the organism / fetus is normal or abnormal (chromosomal numerical abnormalities).
- iv. To determine the type of the cell if it is:



Somatic (Body cell) (Diploid) 2n 46,XX or 46,XY (Pair of each chr)
Gamete (Sexual cell) (Haploid) 1n 23,X or 23,Y (Single copy of each chr).

Somatic (Body cell) (Diploid) 2n 46,XX or 46,XY (Pair of each chr)
Gamete (Sexual cell) (Haploid) 1n 23,X or 23,Y (Single copy of each chr).

**3- Experimental procedure for karyotyping:****4- Criteria applied in step.9: to obtain the karyotype:**

(For study)

- a- Decreasing order of size of the chromosome.
- b- Every two homologous chromosomes are arranged beside each other to form pair.

(Same size, same location of centromere, same banding pattern).  
(They must carry the same genes at the same level but not necessarily the same alleles).

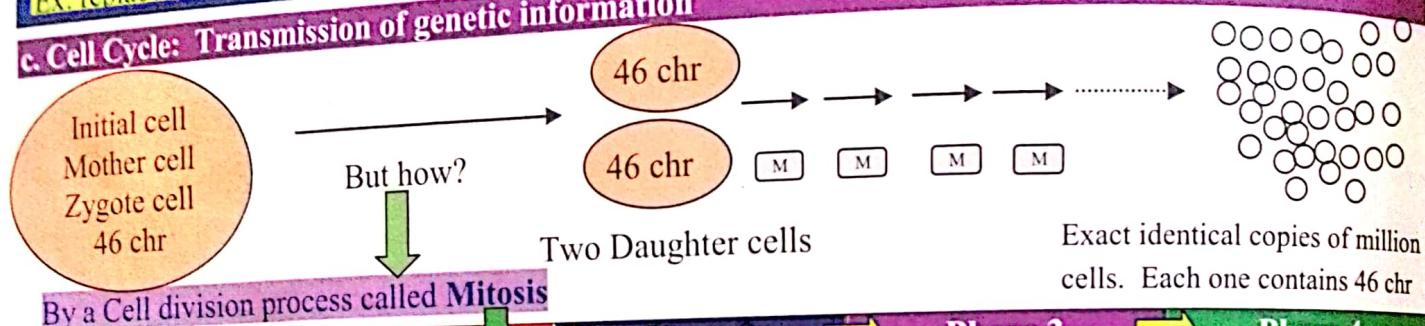
## 1. Mitosis / Mitotic division :

**a. Definition:**

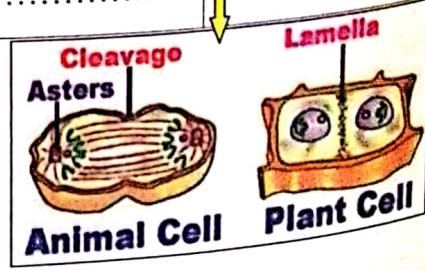
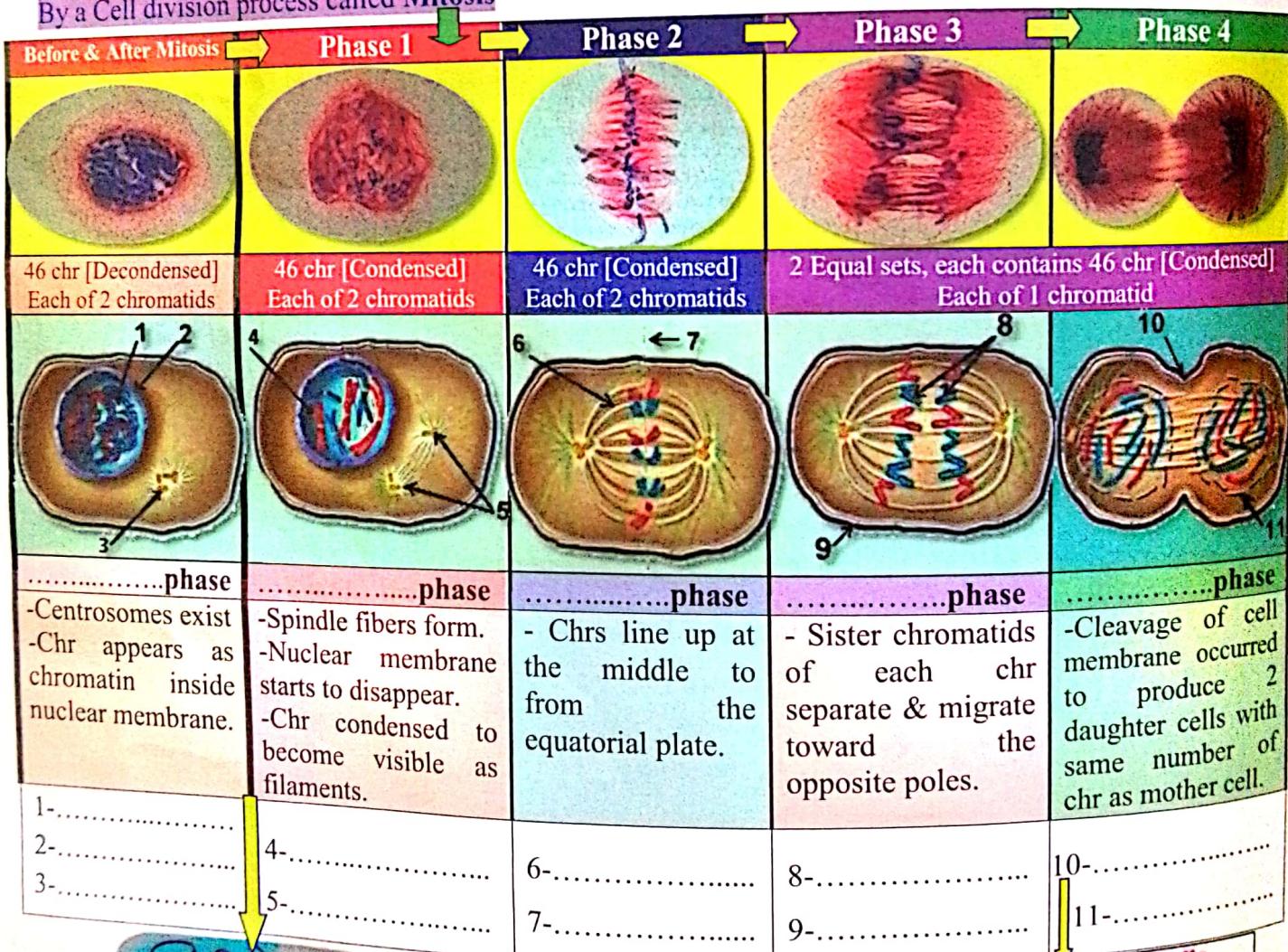
It is the process of cell division of somatic or body cells (non-sexual cells). Every division produces two daughter cells from one initial original mother cell.

**b. Significance / Importance:**

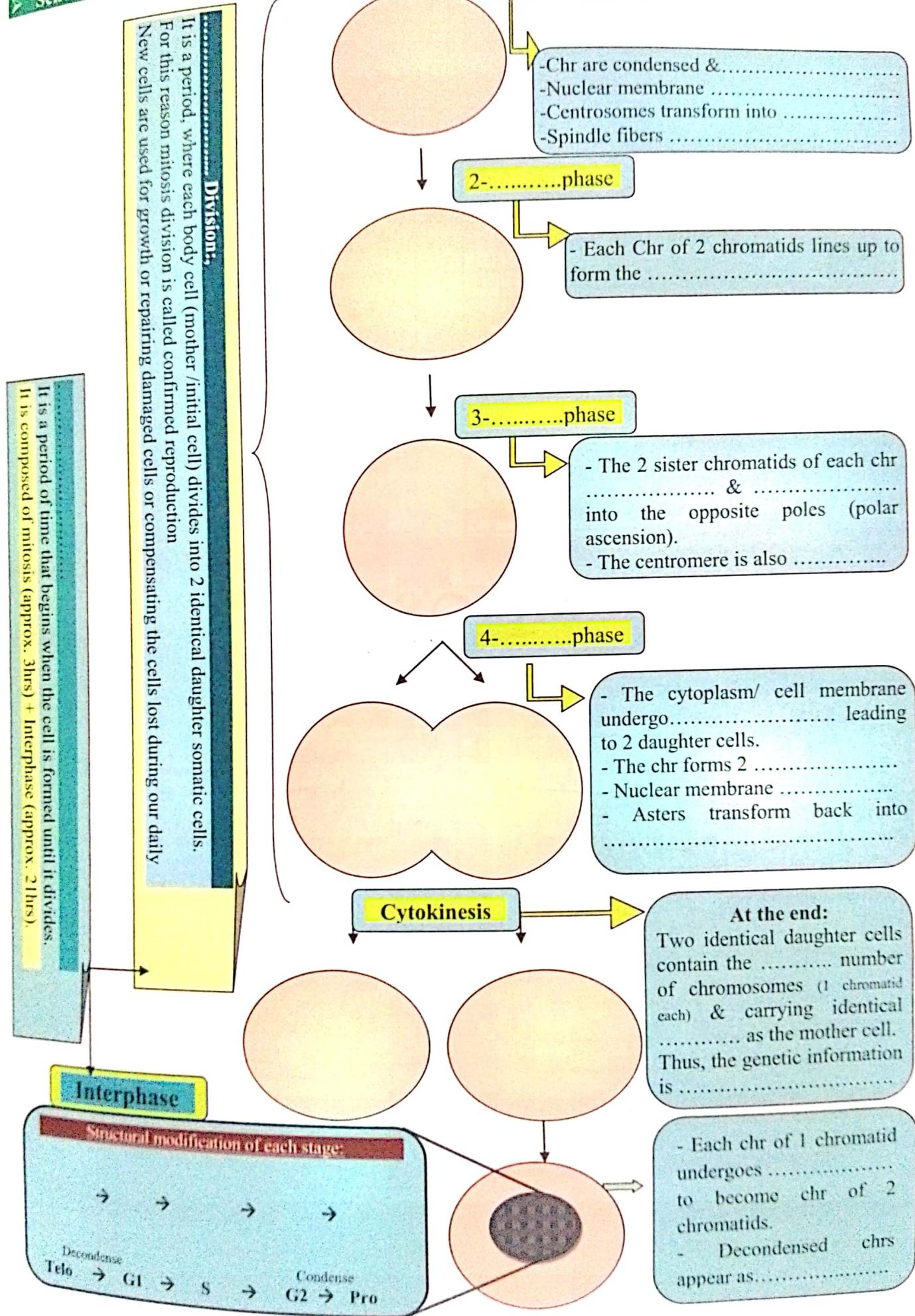
It aids in growth, development, renewal & replacement of old somatic cells by new somatic ones.  
Ex: replace hair loss, nails loss, skin burn or section, & fix bone fractures.

**c. Cell Cycle: Transmission of genetic information**

By a Cell division process called **Mitosis**



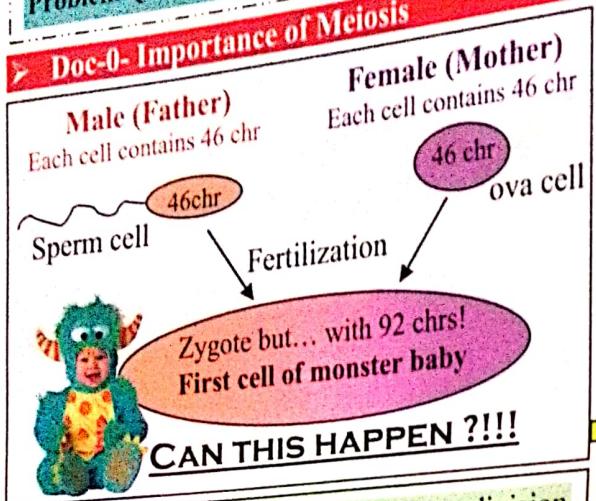
# Schematize a cell ( $2n=4$ with alleles Aa & Bb) during mitosis.



## 2. Meiosis/ Meiotic division:

**Problem Question:** How the zygote is formed from the two parents?

### Doc-0- Importance of Meiosis



### Male (Father)

Each cell contains 46 chr  
Male somatic cell  
(Undifferentiated germ cell:  
spermatogonium)

46chr  
(2n)

Meiosis

23chr

**Sperm cell**

### Female (Mother)

Each cell contains 46 chr  
Female somatic cell  
(Undifferentiated germ cell: Oogonia)

46chr  
(2n)

23chr

**Ova cell**

**Zygote 46 chr**  
**First cell of normal baby**

**THANKS GOD.. ☺**  
**MEIOSIS SOLVED THE PROBLEM!**

**So Meiosis:** Is a process of cellular division that aims to produce a haploid gamete cells ( $1n=23$ ) in order to make sexual reproduction.

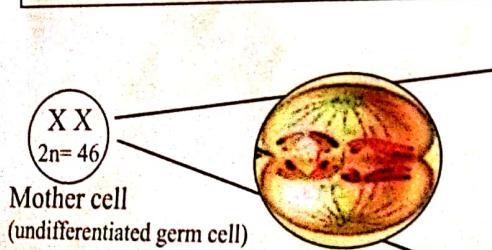
**So, without meiosis, no fertilization no reproduction.**

### Doc.2 – Main Events of Meiosis

# MEIOSIS

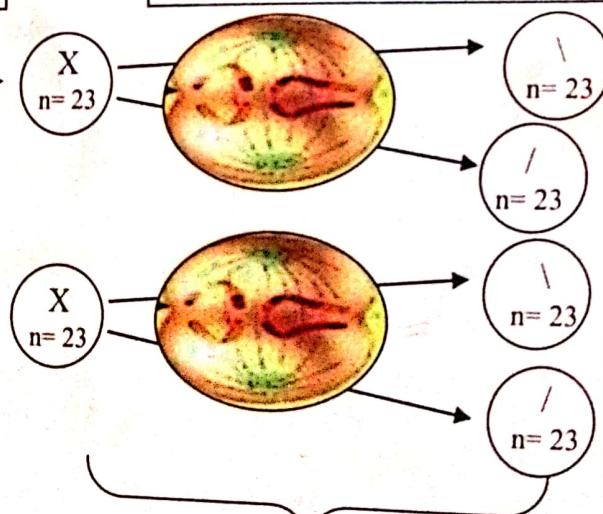
### MEIOSIS I [Reductional division]

One cell Produces two cells, each has half number of chrs ( $1n=23$ ) as mother cell ( $2n=46$ )



### MEIOSIS II [Equational division]

Two cells produce four cells, each has same number of chrs ( $1n=23$ ) as the initial cell of this div.



At end:  
4 gametes  
(Still need differentiation)

One of them will have the luck to fertilize the other gamete of the other sex.

**Pro-1**   **Met-1**   **Ana-1**   **Telo-1**

Separation of homologous pair chr

**Pro-2**   **Met-2**   **Ana-2**   **Telo-2**

Separation of sister chromatids

### Significance of Meiosis

It aids in the formation of genetically different gametes and it increases diversity or polymorphism at the level of the phenotypes in the population or species.

Phases of Meiosis (Meiotic division) /Schematize using  $2n=4$ :1<sup>ST</sup> MEIOTIC DIVISION: (PMAT)<sub>1</sub> REDUCTIVE DIVISION**Prophase-1:**

Homologous pairs (synapses) to form tetrads.

**Metaphase-1:**

Homologous pairs line up to form the equatorial plate.

**Anaphase-1:**

Homologous pairs separate & migrate towards the opposite poles of the cell (polar ascension).

**Telophase-1:**

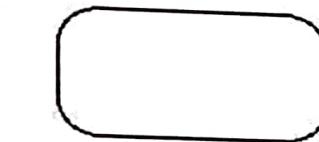
A constriction appears at the middle of the cell leading to its cleavage to obtain 2-daughter cells each has 1n-d.  
(Reductive division: it is named so because the number of chrs. is reduced to half its value ( $2n=46 \rightarrow 1 n=23$ )).

Prophase I

Metaphase I

Anaphase I

Telophase I

2<sup>ND</sup> MEIOTIC DIVISION: (PMAT)<sub>2</sub> EQUATIONAL DIVISION**Prophase -2**

It is the same phase as telophase-1:

Single chrs of double chromatid each, is visible inside the disappearing nuclear membrane.

**Metaphase-2:**

Each single chr line up to form the equatorial plate.

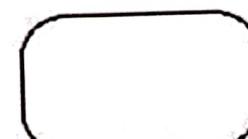
**Anaphase-2**

Each 2 sister chromatids of each chr separates & migrates towards the opposite poles (Polar ascension).

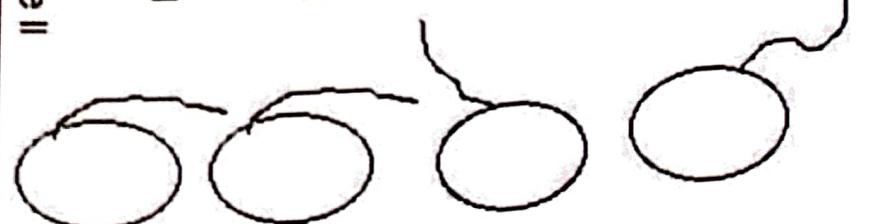
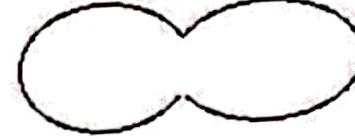
Prophase II

Metaphase II

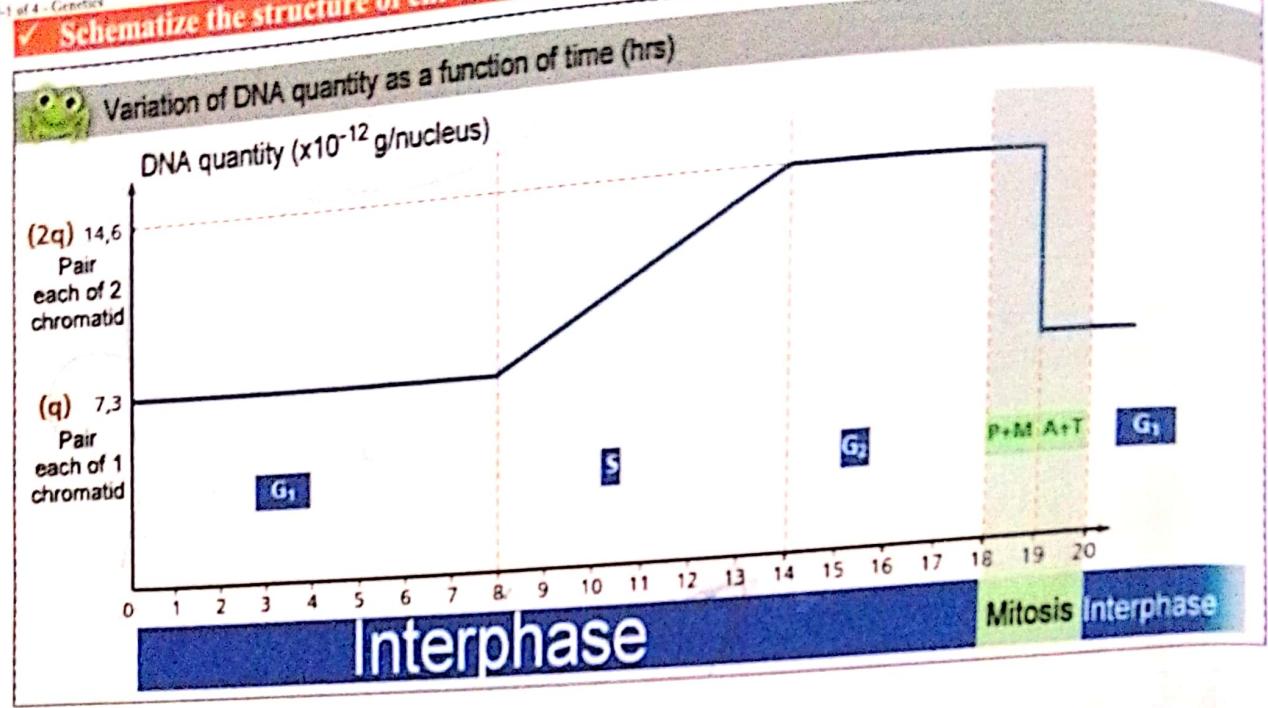
Anaphase II



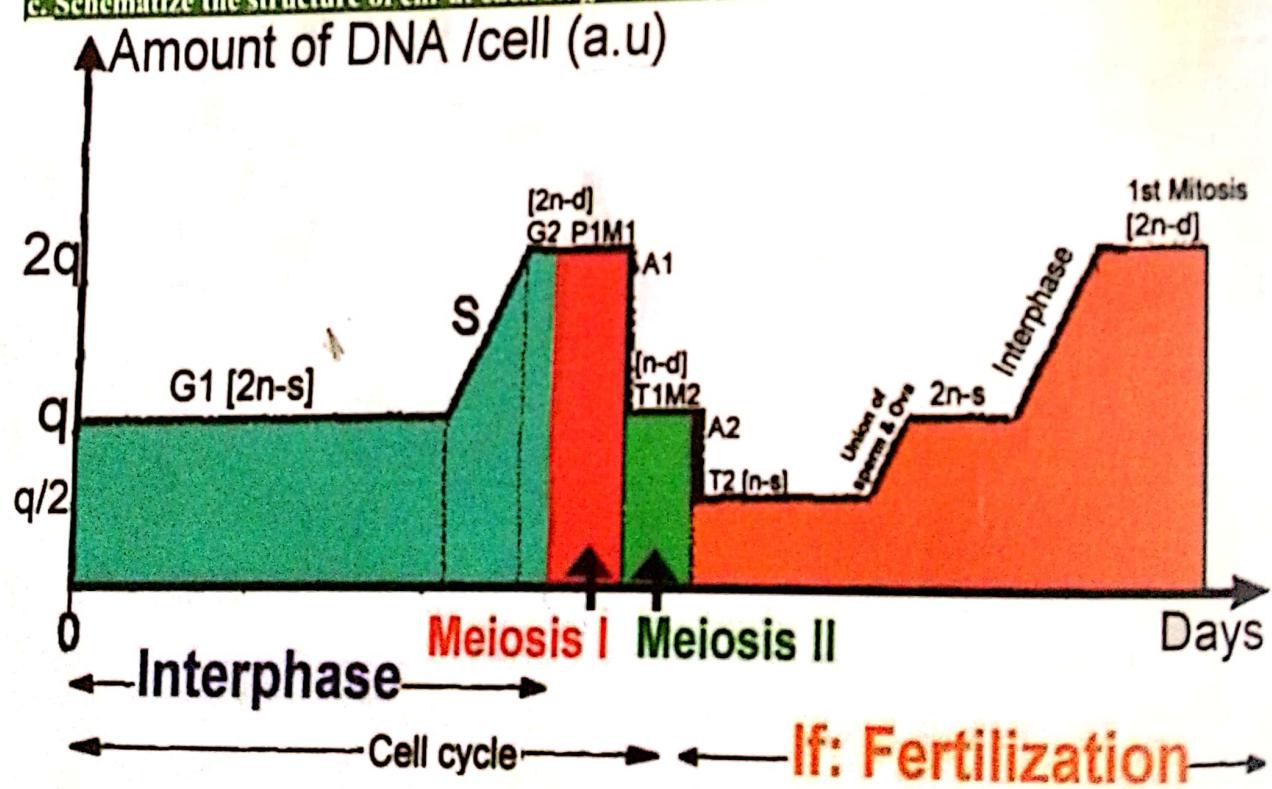
Telophase II



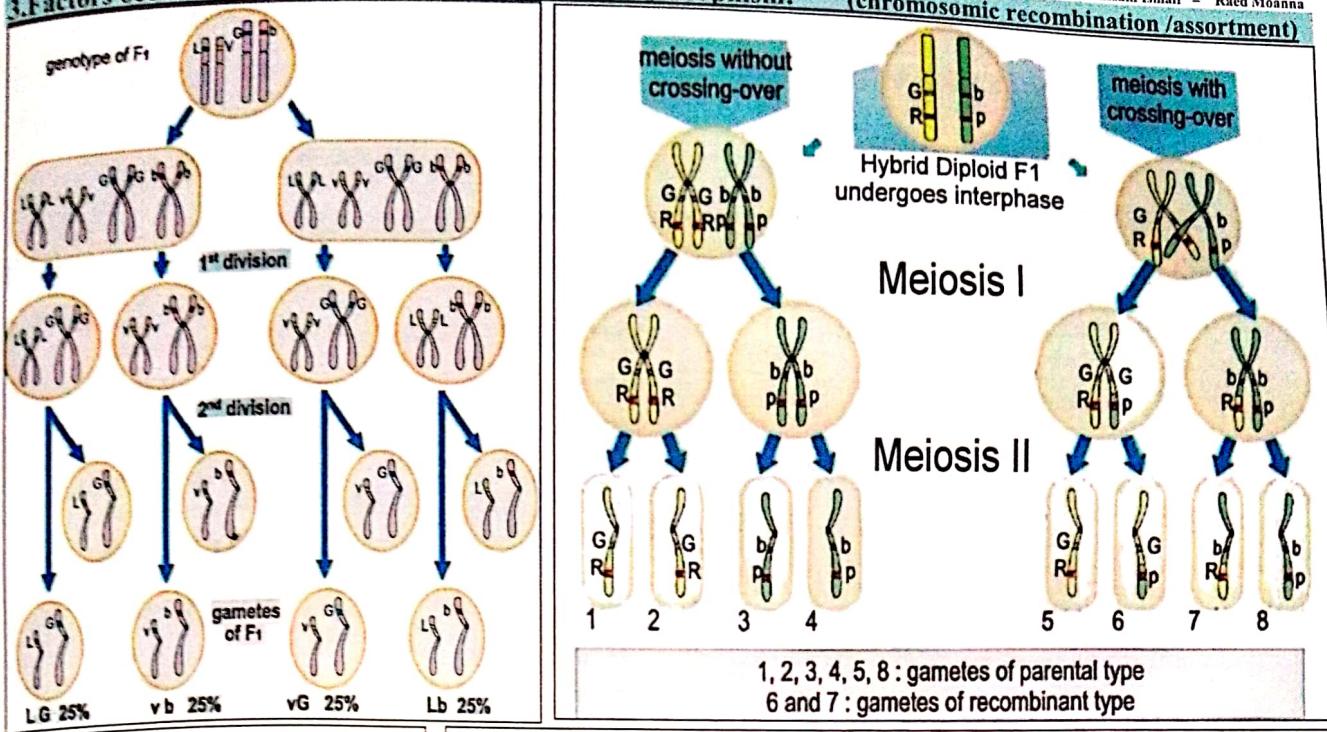
✓ Schematize the structure of chr at each stage of interphase & mitosis. ( at the graph)



c. Schematize the structure of chr at each stage of interphase & Meiosis (Cell Cycle). At the given table.



## 3. Factors occur during meiosis &amp; aid in diversity/polymorphism:

**i. Inter-chromosomal recombination:**

-It is the random separation or disjunction /segregation /migration of homologous chrs. during Ana-1 & sister chromatids during Ana-2.

**ii. Intra-chromosomal recombination (crossing over):**

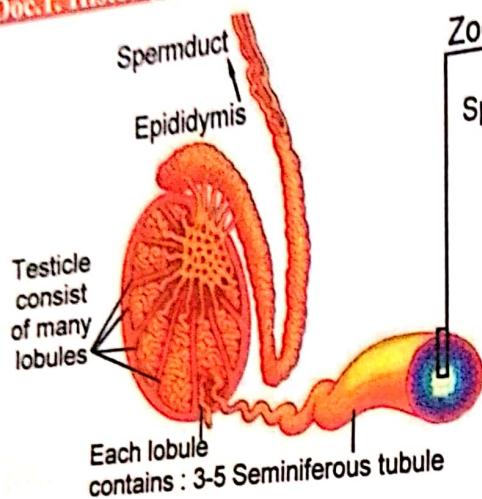
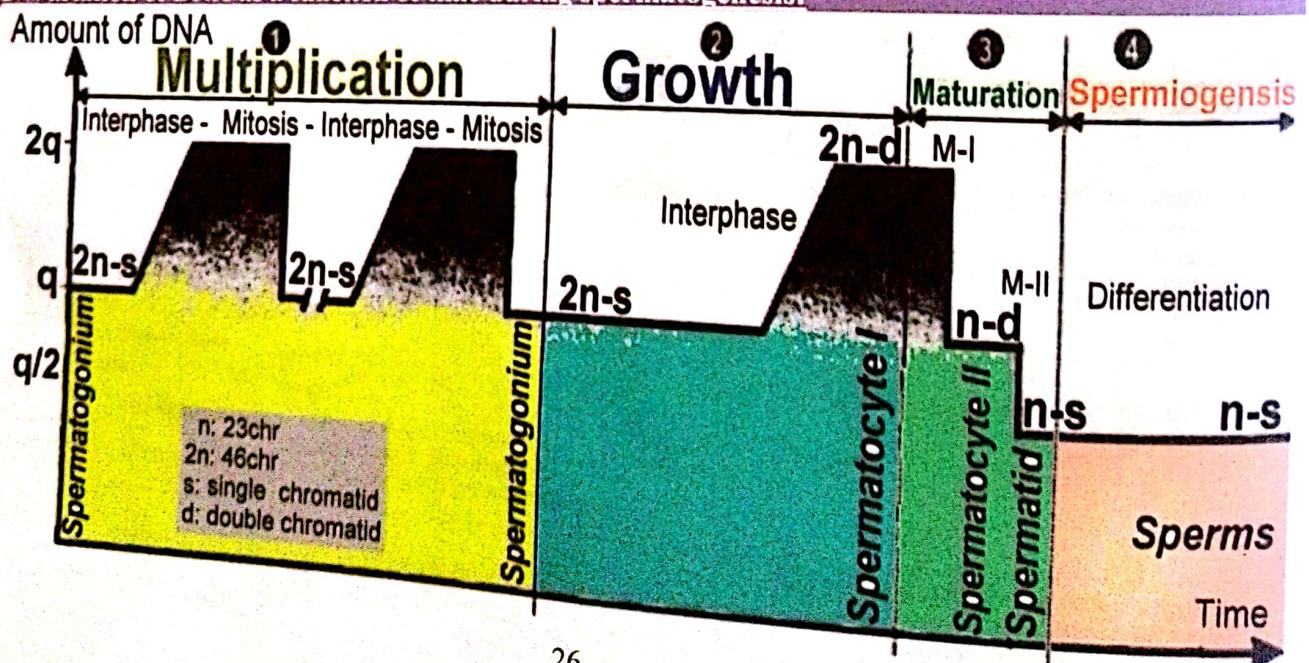
-It occurs at the end of Pro-1 during the formation of tetrads (pairing of homologous chrs.). During this process, the non-sister chromatids of homologous chrs exchange DNA fragments with each other (allelic recombination) leading to the production of new combinations of alleles among chrs, leading to the production of genetically different gametes causing diversity & polymorphism.

**4-Comparison of main characteristics between mitosis and meiosis:**

Mitosis in somatic cells	Meiosis in germ cells
a cell division producing two daughter cells 	two cell divisions leading to 4 gametes 
the number of chromosomes per nucleus is maintained (an example of diploid cells) 	number of chromosomes divided by two in the produced gametes 
a premitotic S phase for each cell division (an example of a diploid cell) 	one premeiotic S phase for both cell divisions 
no synapsis of homologous chromosomes 	full synapsis of homologous chromosomes during prophase I 
no crossing-over	at least one crossing-over per pair of homologs 
the centromeres divide during anaphase 	the centromeres do not divide during anaphase I but during anaphase II 
the daughter cell genotypes are identical to parental genotypes (a conservative phenomenon)	favors the diversity of the produced gametes

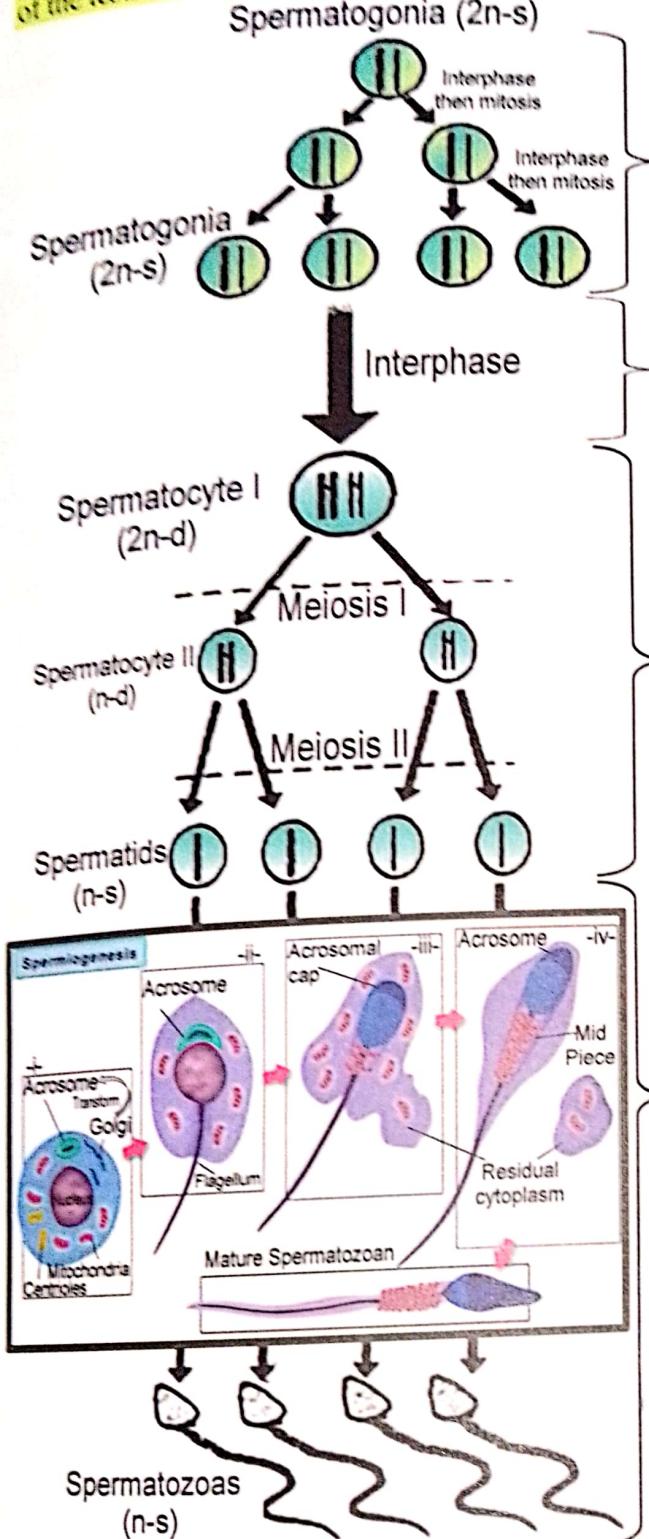
**Doc-4****Spermatogenesis****Definition of Spermatogenesis:**

- It is the set of modifications or transformations or changes that the germ cells undergo to produce functional spermatozoa.
- Undifferentiated stem cells (spermatogonia) undergo to produce functional spermatozoa.
- It occurs at the level of the seminiferous tubules found within the lobules of the testes.

**Doc-1. Histology of the testes:****Spermatogenesis****3- Variation of DNA as a function of time during spermatogenesis:**

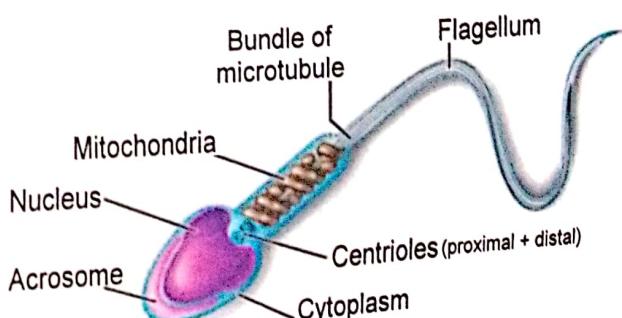
## 2-Phases of Spermatogenesis (Doc-d)

It is a continuous process of producing haploid spermatozoa inside the seminiferous tubules of the lobules of the testicles; it starts at puberty & ends at death. It consists of 4 stages as follows:



We are ready ... Sir :) waiting your commands !!!

⌚ **Temporary suspended**



## Doc-5

## • Oogenesis



## ► Doc.1. Introduction :

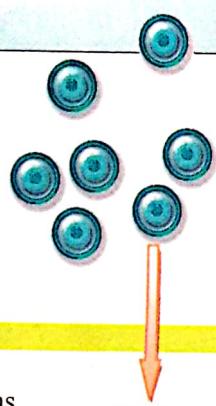
For sexual maturation in females, certain changes should take place during fetal life before her birth. These events are resumed at puberty & end at menopause. These changes occur at two levels:

- 1- Changes at the level of germ stem cell to produce the haploid gamete. This is called oogenesis (Doc-3)
- 2- Changes at the level of the cells surrounding the gamete (follicles). This is called folliculogenesis (Doc-2)

## ► Doc.2. Folliculogenesis

Folliculogenesis is the maturation (development cycle) of the ovarian follicle (group of small cells surrounding & protecting the immature gamete). It starts during fetal life then pause at birth then resumes at puberty.

Formation of millions primordial follicle inside the ovary of the female fetus.



These follicles are arrested until puberty which is 4 months before the start of the first cycle

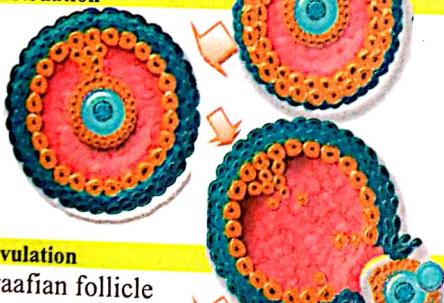
**Puberty**

they start to transform into primary follicle then to secondary follicle then to tertiary / cavitary follicle



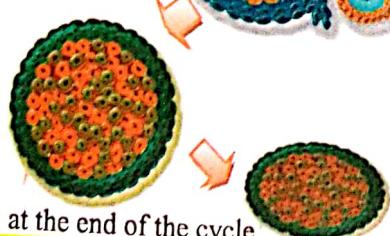
**Menstruation**

One of the tertiary follicles Transforms into a mature Graafian follicle



**Ovulation**

The empty Graafian follicle Transforms into Yellow body (corpus luteum) Then into White body (corpus albicans) which degenerates at the end of the cycle



## ► Doc.3. Oogenesis

Oogenesis starts before birth in the ovaries, pauses at birth & then resumes at puberty & ends in the oviduct; This process is periodically repeated & interrupted by 2 blockages & it is incomplete if no fertilization took place. Oogenesis stops at menopause. It aims to produce a haploid gamete which is ready for any possible fertilization.

**Age**

**Fetal life**

**Birth**

**Puberty**

Months  
-4  
-3  
-2  
-1

**Cycle starts Day 0**

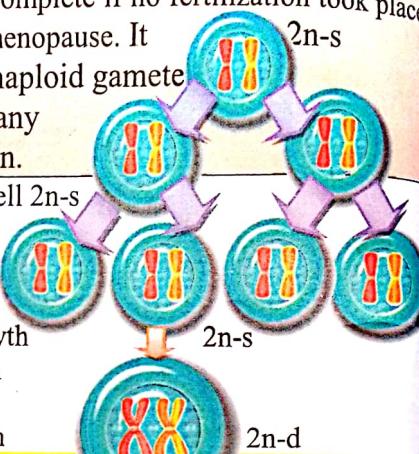
**Follicular phase**

**Day 14**

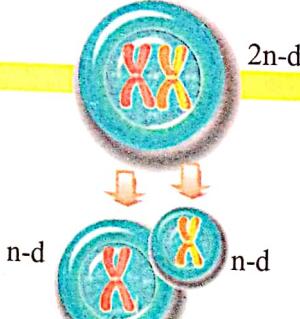
**Luteal Phase**

**Day 28**

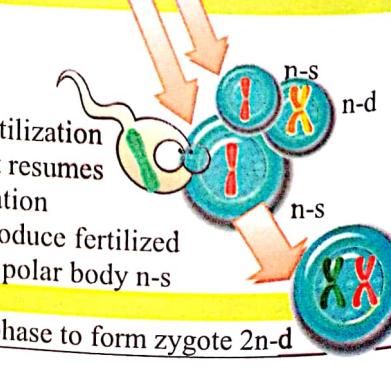
Diploid germ stem cell 2n-s undergoes multiplication by mitosis Then undergoes growth by interphase to form oocyte I 2n-d which arrest at Pro-1 at birth



Resumes Meiosis I to produce 1<sup>st</sup> polar body & oocyte II n-d 18 hours before



**ovulation**  
oocyte II arrested at Meta II in the oviduct



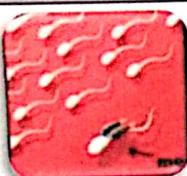
Karyogamy then interphase to form zygote 2n-d

## Doc-6

## • Fertilization

## 1. Introduction:

-Fertilization is the process of union or fusion between the haploid male gamete (sperm cell) & the haploid female gamete (ovum or oocyte) to reestablish or restore the diploidy state of a new organism (zygote).

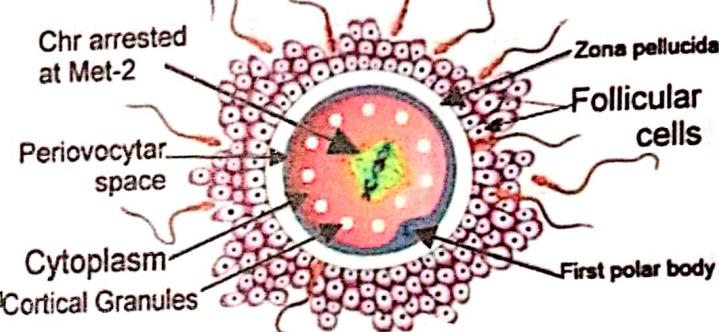
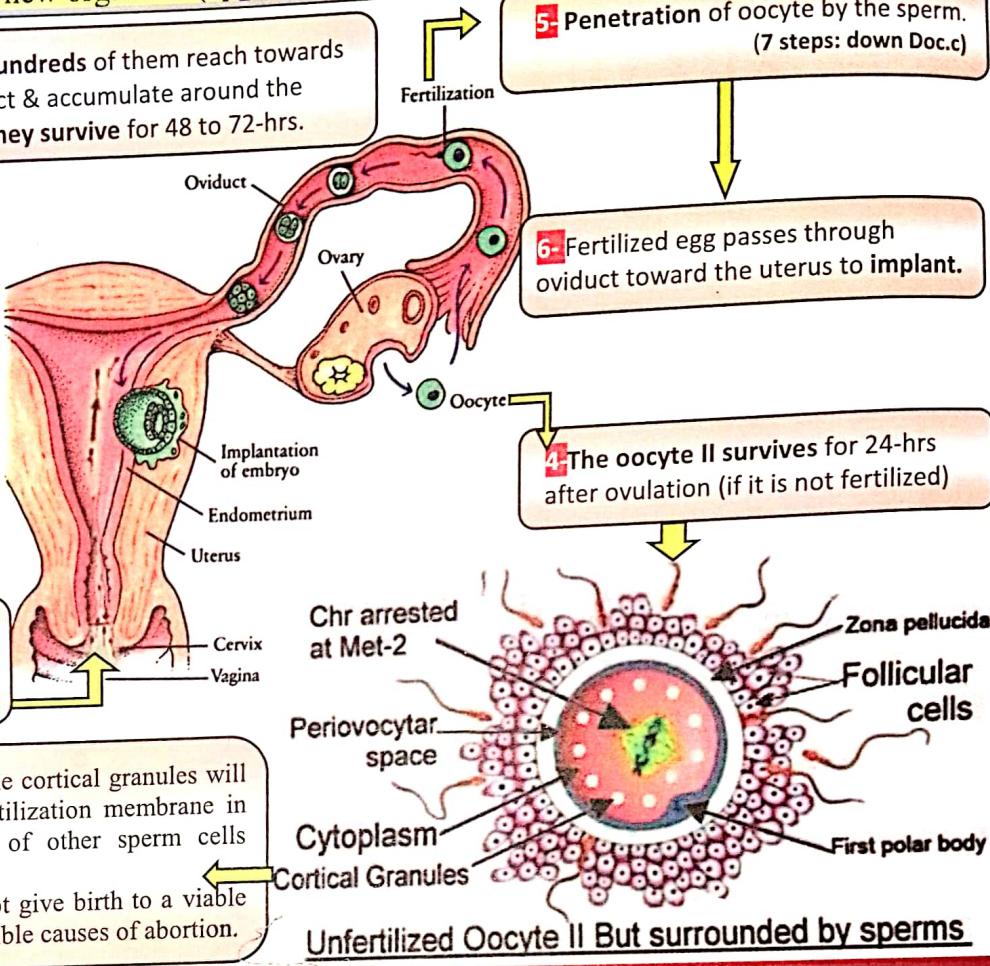


3- Only Hundreds of them reach towards the oviduct & accumulate around the oocyte. They survive for 48 to 72-hrs.

5- Penetration of oocyte by the sperm. (7 steps: down Doc.c)

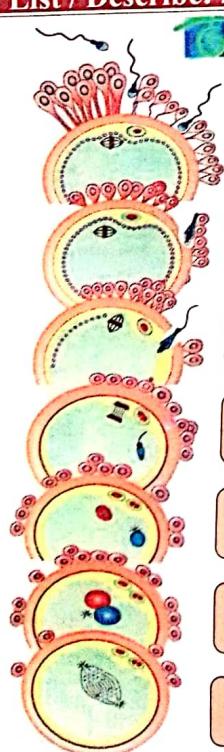
2- Most spermatozoa degenerate during their passage in the female genital tract due to the immune response organized or mounted by the female immune system.  
- Sperms acquire its fertilization capacity in the female genetic tract.

1- During sexual intercourse, millions of sperms are deposited in the vagina.



Unfertilized Oocyte II But surrounded by sperms

## 2. List / Describe: Steps of fertilization:



## 1- Recognition

1- The sperms are recognized & entrapped within the viscous substance that links the pedunculated follicular cells.

## 2- Retraction

2- Pedunculated cells contract absorbing the sperm inside.

## 3-Acrosomal Rxn

3- The zona pellucida is digested by the acrosomal enzymes facilitating the passage of the spermatozoon into oocyte II.

## 4- Fusion

4- Membranes of sperm cells & oocyte fuse together.

## 5- Release

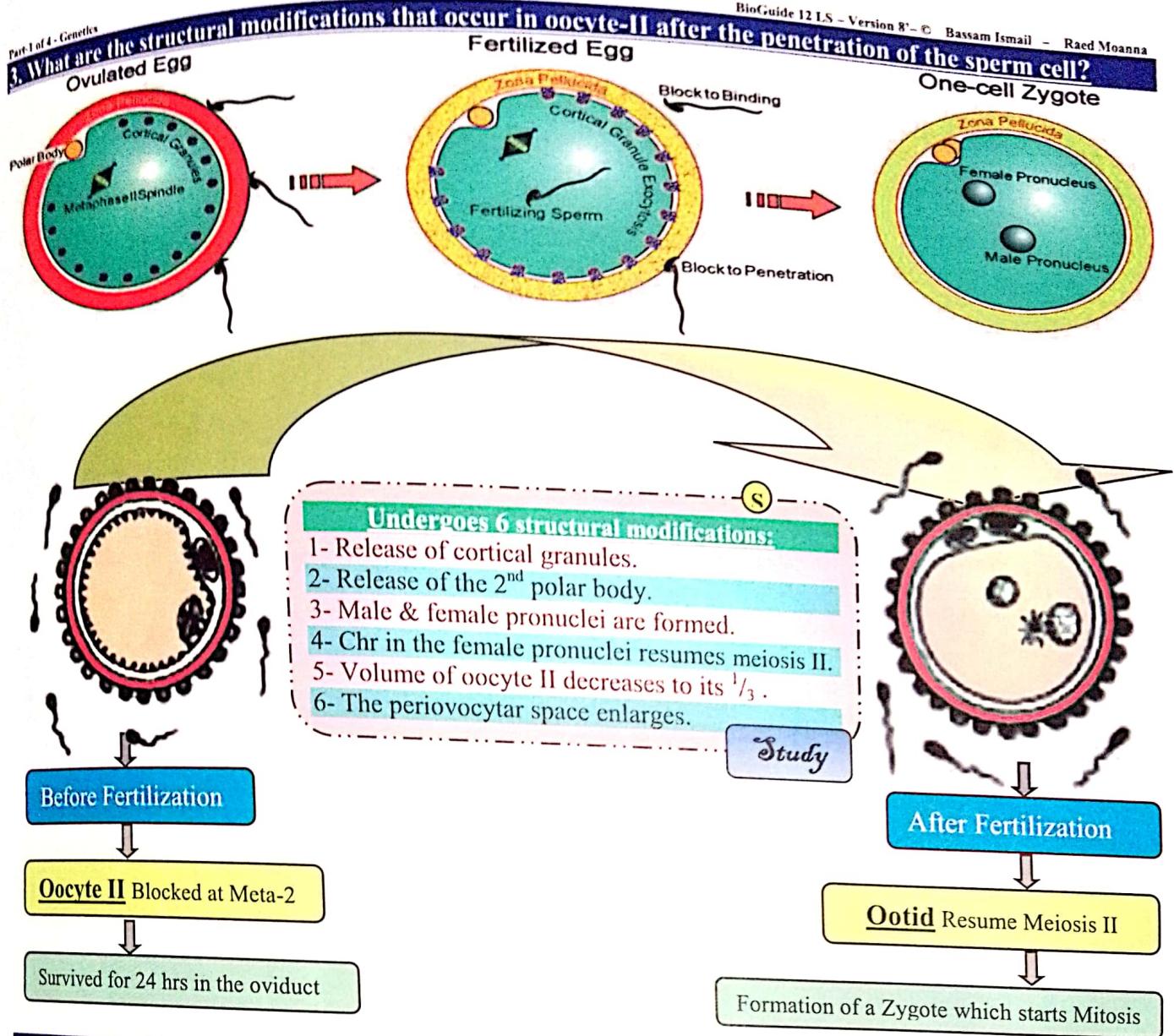
5- Cortical granules are released & the second polar body produced too.

## 6- Karyogamy

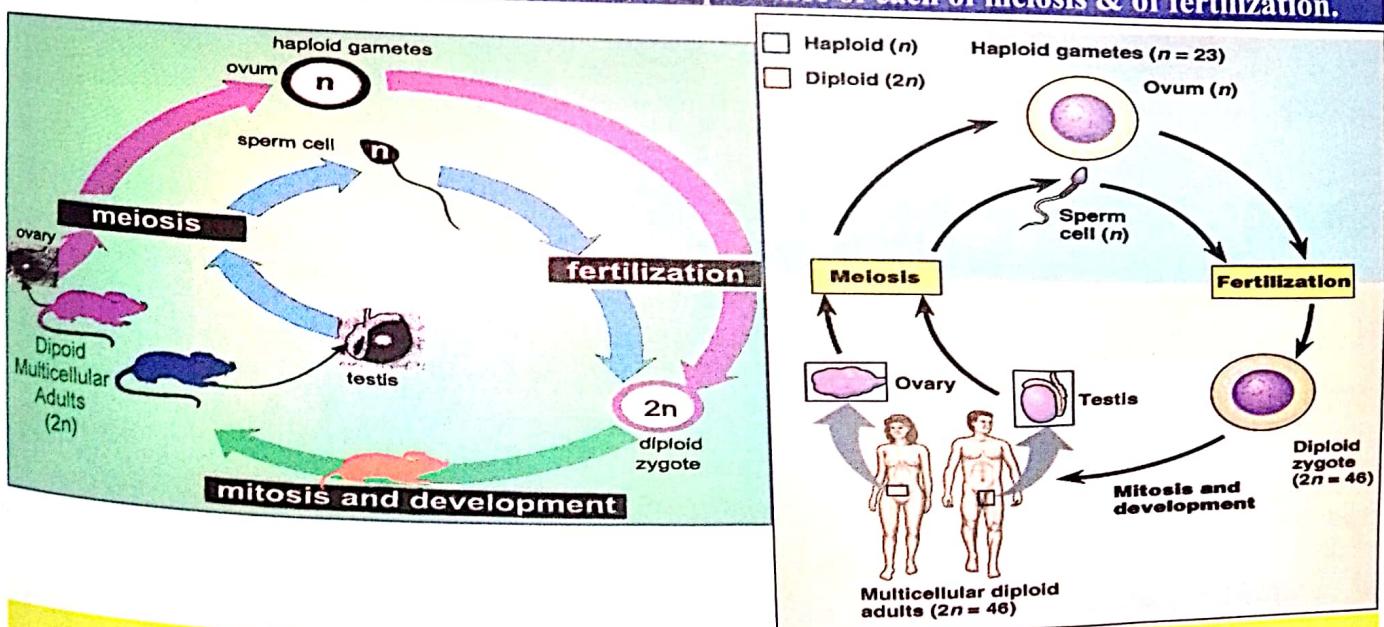
6- Male & female pronuclei are formed then they union by a process called (Karyogamy) leading to the formation of the zygote.

7- 1<sup>st</sup> Mitosis

7- The zygote starts its first mitotic division.

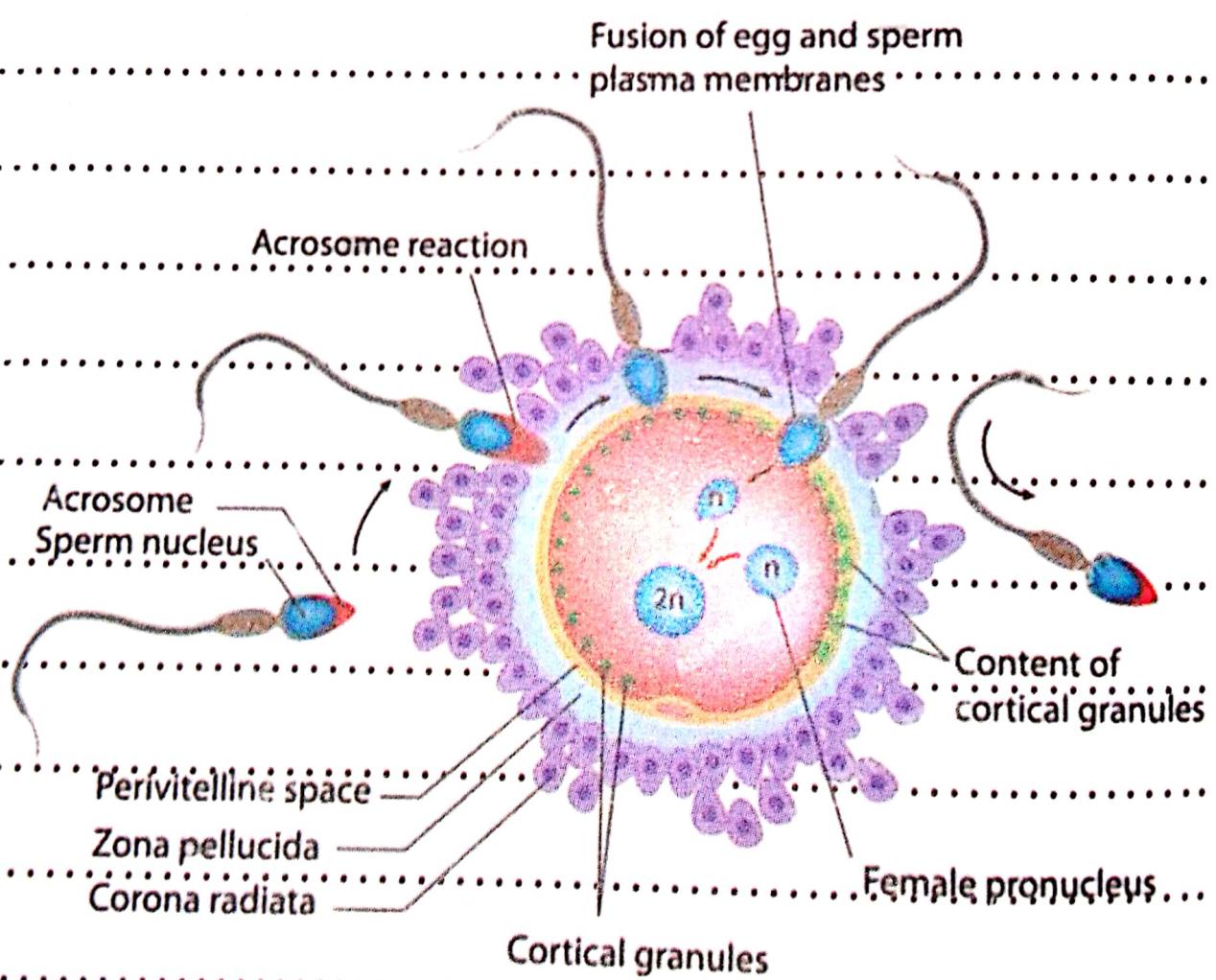


**4. Life cycle of sexually reproducing organisms / Importance of each of meiosis & of fertilization.**



### As a Conclusion:

Sexual reproduction done by 2 mechanisms:	Meiosis	Fertilization
Importance of each Mechanism:	Produces haploid gametes $1n$	Produces diploid cell zygote $2n$



PRACTICE MORE!



PREPARE THE WAY  
To your exams

Ch-1

• 34 Questions

2

✓ Lebanese Official Bac

➤ Number 1 → 2

24

✓ Solved Exercises

➤ Number 3 → 26

8

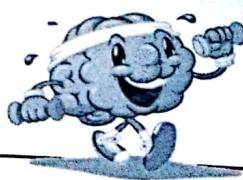
✓ Practice Alone

➤ Number 27 → 34

Temporary suspended

Hints in solving the exercises:

- 1- Read carefully the whole given (text+ document).
- 2- Underline the keywords that indicate if the process is oogenesis or spermatogenesis or spermogenesis, or fertilization or mitosis alone.
- 3- Underline the objective – hypothesis or problem if exist in the text.
- 4- Write an indication beside each document given.
- 5- Colorize if needed.
- 6- Underline each single action verb.

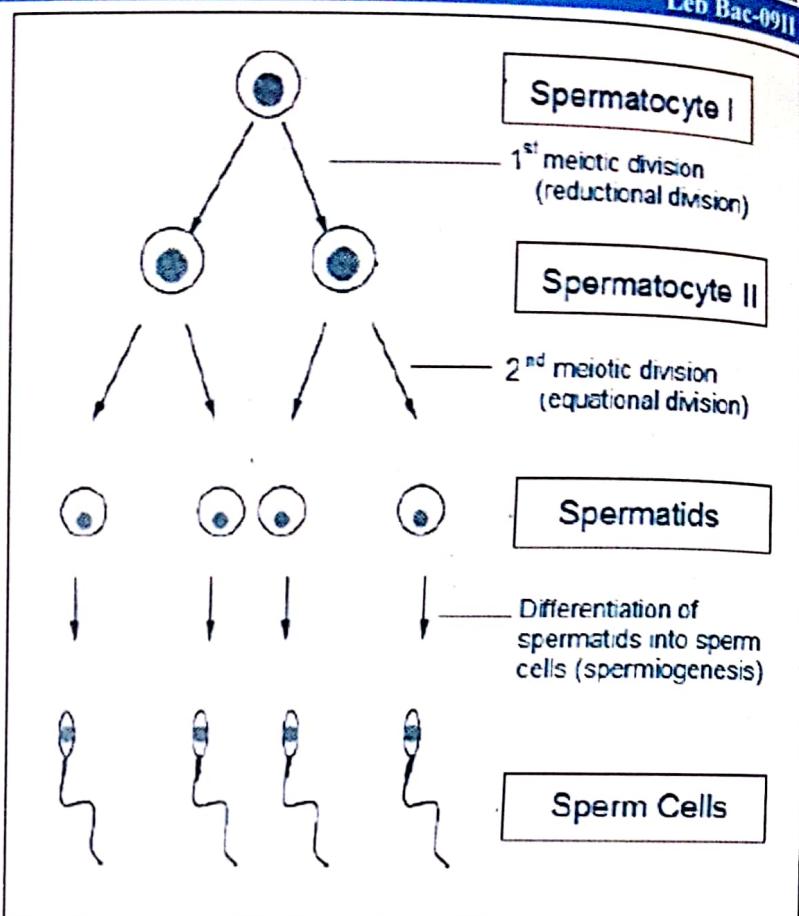


**Question-1- A Case of Sterility**

Mr. X and Mr. Y are two adult sterile men. We perform different tests to specify the origin of this defect.

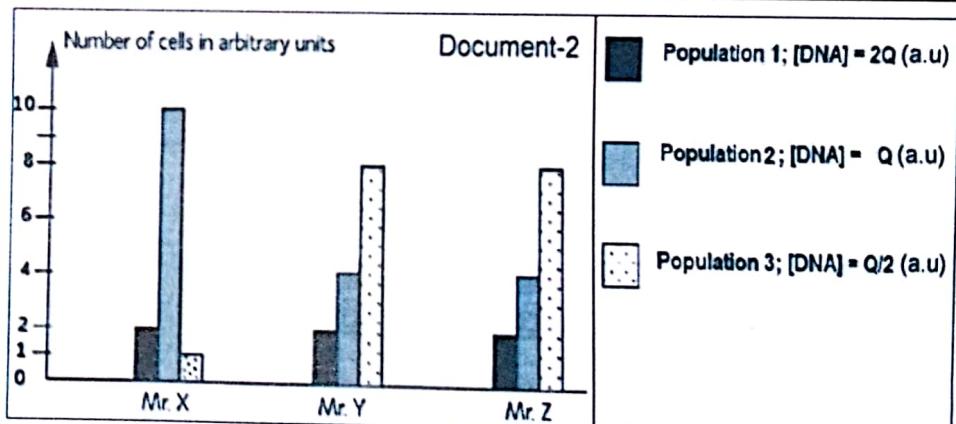
Document 1 shows certain stages of spermatogenesis. The germ cells, whose names are framed in boxes, are found in the wall of the seminiferous tubules.

- 1- Describe the different stages of spermatogenesis represented in document 1.



We perform a quantitative study for the amount of DNA of the germ cells extracted directly, by biopsy, from a fragment of the testicles of these two sterile men and that of a fertile man Mr. Z.

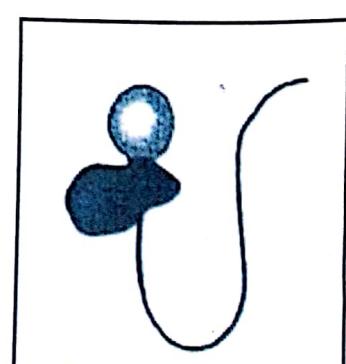
3 different populations of germ cells are obtained. The number of each cell population, as well as the amount of DNA in each of them is shown in doc 2.



- 2- Indicate the germ cells corresponding to each of the three populations shown in document-2. Justify.

- 3- Explain the variation of the number of germ cells of the three populations in the fertile man Mr. Z.

- 4- Determine, by referring to document 2, the cause of sterility of Mr. X.



Microscopic observations of the semen of Mr. Y showed sperm cells, where the majority of these cells showed an aspect identical to that schematized in doc-3.

- 5- Explain the origin of the sterility of Mr. Y.

**Document 3**

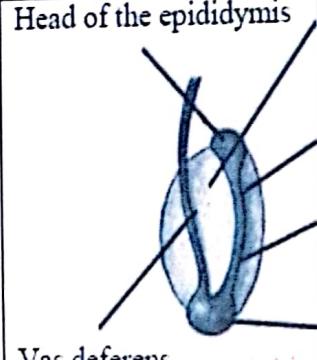
**Part-1 of 4 - Genetics  
Question-2-**

We are interested in studying the events that accompany the sexual reproduction in mammals. These events are studied at cellular and molecular levels.

Female rabbits were mated with sterile males in order to induce ovulation, and then they were inseminated with sperm cells taken from different levels of the genital tract of adult fertile male rabbits. One day following the insemination, the aspect of the cells that were taken from the oviducts was observed under the microscope.

**Document 1** presents the % of the two main aspects: (schema X & Y) observed according to the site where the sperm cells were removed.

Aspect of the cells taken from the oviducts one day after the insemination	Site from where sperm cells were removed.	
	X	Y
Head of the epididymis	Testicle	100% 0%
Proximal part of the body of the epididymis	85%	15%
Distal part of the body of the epididymis	35%	65%
Tail of the epididymis	8%	92%

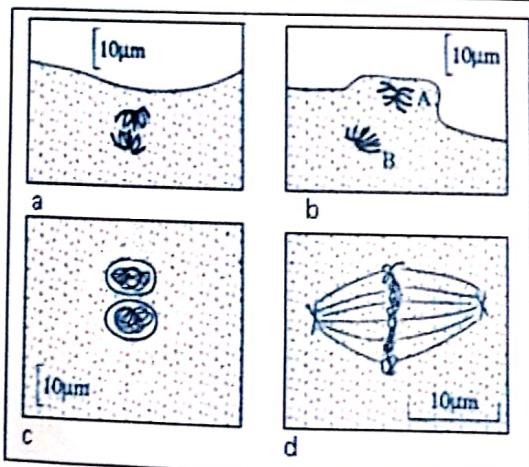


1. Explain briefly the structural modifications that take place during the passage of the cell from aspect X to aspect Y.

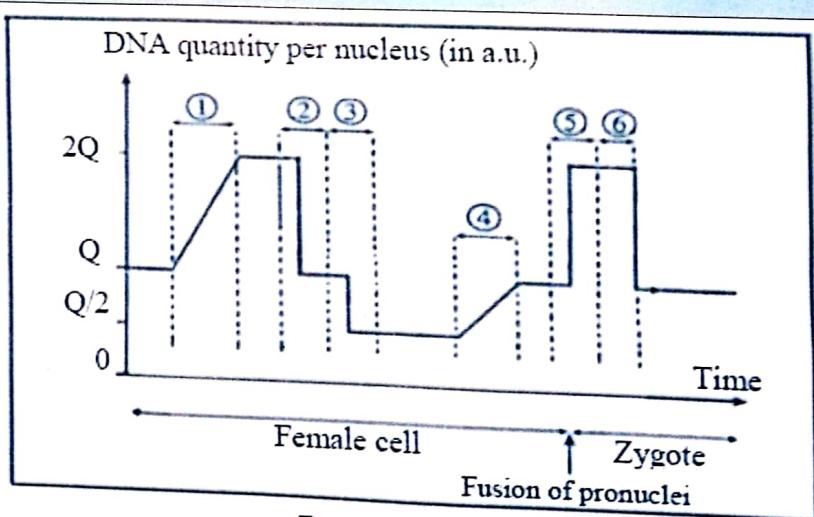
2. Determine, by referring to document 1, the role of the epididymis.

**Document 2** reveals, in chronological order, some steps of the evolution of the fertilized oocyte II and that of the zygote.

**Document 3** represents the evolution of the DNA quantity per nucleus of the female cell and that of the zygote.



**Document 2**



**Document 3**

3. 3-1- Name the two principal mechanisms of the sexual reproduction in mammals.

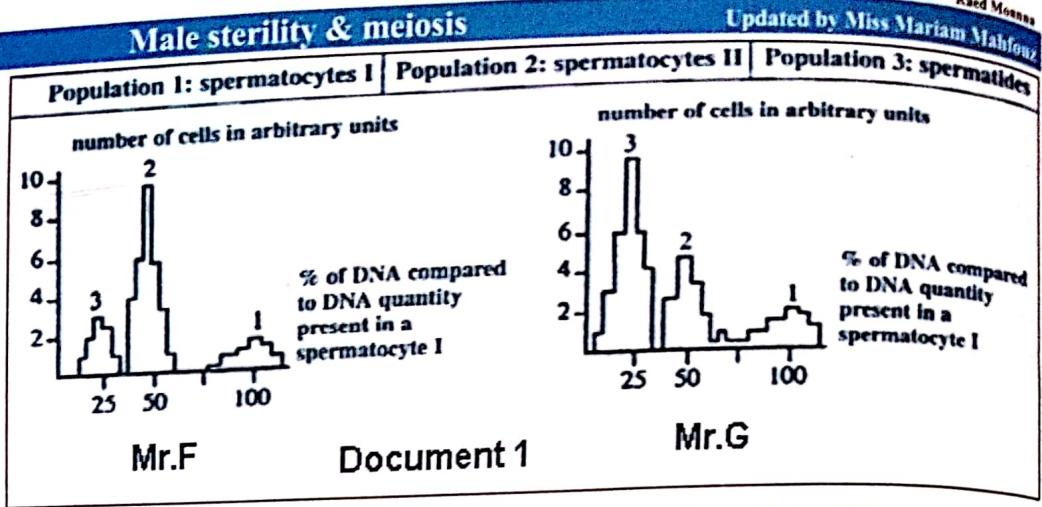
3-2- Specify the importance of each of these mechanisms. Justify the answer by referring to doc-2.

4. Match each of the schema b, c and d of document 2 with a numbered step of the curve of document 3. Justify the answer.

## Part-1 of 4 - Genetics

**Question-3-**

A quantitative study of the value of DNA done on a suspension of sexual cells, the testes of Mr. F and Mr. G of which one of them is sterile. The results are summarized on the histograms of document 1



- 1-1- Compare the results of Mr.F and Mr.G. shown in document 1. Conclude which of the two men is sterile.
- 1-2- Formulate a hypothesis which may be the possible origin of the observed sterility.

We establish the spermatocyte's karyotype for the sterile Man (document 2): 50% of cells have the karyotype (a) and 50% the karyotype (b). Document 2 →

- 2- Indicate to which cell population, in the histogram (1 or 2 or 3) do these karyotypes correspond? Justify your answer.

X	X	X	X	X	X	X
1	2	3	4	5	6	X
X	X	X	X	X	X	
7	8	9	10	11	12	
X	X	X	X	X	X	
13	14	15	16	17	18	
X	X	X	X			
19	20	21	22			

**Karyotype a**

X	X	X	X	X	X
1	2	3	4	5	6
X	X	X	X	X	X
7	8	9	10	11	12
X	X	X	X	X	X
13	14	15	16	17	18
X	X	X	X		
19	20	21	22		

**Karyotype b**

- 3- Knowing that we find very few cells of population 3, draw a schema showing the steps of the possible spermatogenesis of the sterile man. (Take  $2n=4$  chromosomes).
- 4- Verify if the schema validate the hypothesis mentioned above.

The sterile man follows a medical treatment (injections of testosterone) which cures him of sterility. The karyotypes of the majority of the germinal cells that are found in the lumen of his seminiferous tubules are shown in document 3.

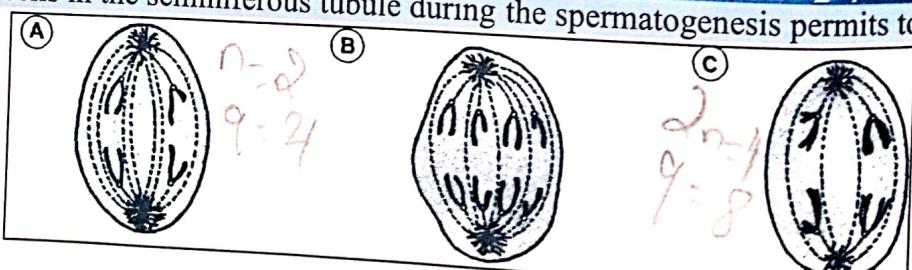
>	<	)	(	>	{	\
1	2	3	4	5	6	X
(	(	)	)	(	)	
7	8	9	10	11	12	
\	\	\	\	\	\	
13	14	15	16	17	18	
\	\	\	\	\	\	
19	20	21	22			

>	<	)	(	>	{	\
1	2	3	4	5	6	
(	(	)	)	(	)	
7	8	9	10	11	12	
\	\	\	\	\	\	
13	14	15	16	17	18	
\	\	\	\	\	\	
19	20	21	22			

- 5- Show that these data allow the confirmation of your hypothesis about the origin of the man's sterility.

**Question-4-****Phases of Spermatogenesis**

The microscopic observation of the cells in the seminiferous tubule during the spermatogenesis permits to perform the 3 interpretation diagrams in the following figure; these 3 diagrams correspond to the same phase for 3 different division.



1. Identify the phase of each figure.
2. Classify these diagrams in the chronological order during spermatogenesis.

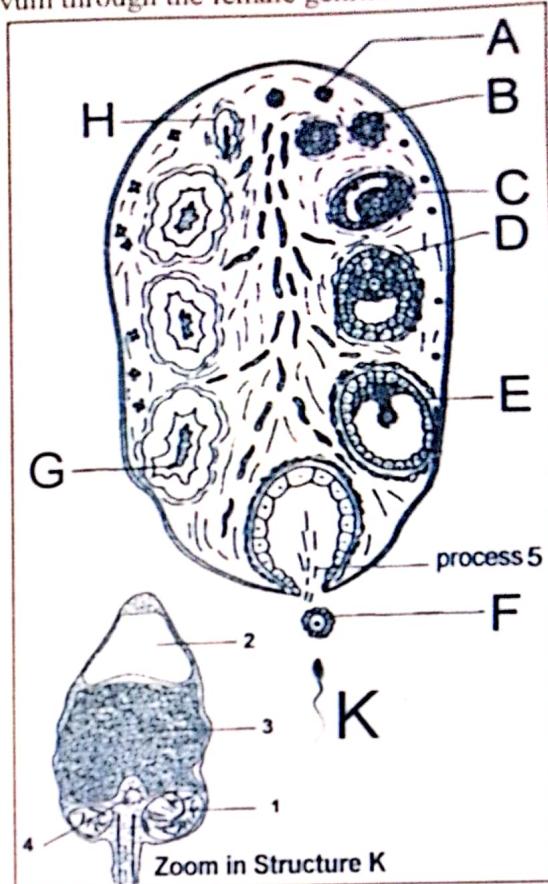
**Part 1 of 4 - Genetics  
Question-5.****Reproduction and Spermatozoids.**

The spermatozoid is a very specific cell capable of moving to meet the ovum through the female genital ducts.

1- Label A to K then 1 to 5.

- ❖ **Exp1.** Spermatozoa are removed from the seminiferous tubules and are introduced into the uterus. No significant migration towards the fallopian tubes is observed.
- ❖ **Exp2.** The sperm taken from the vas deferens canal is introduced into the uterus; fertilization is normal.
- ❖ **Exp3:** The sperm taken from the vas deferens canal is put in a test-tube in the presence of ova. No fertilization was possible.
- ❖ **Exp4.** Injection of spermatozoa into an oocyte leads to fertilization. The element 2 of figure 1 remains intact, but it normally opens when in contact with the oocyte.
- ❖ **Exp5.** We separate active spermatozoa from the remaining sperm, before placing them in a physiological solution deprived of fructose. Sperms become immobile & incapable of fertilization.

2- Interpret the following experiments; conclude the conditions needed for spermatozoids action.

**Question-6-Meiosis in drosophila**

Σ Updated- by Mr Mahmoud Biado

The following drawings represent the Karyotypes of two drosophila A and B of different sex of  $2n = 8$ .

- 1- Knowing that the male drosophila contains different gonosomes, compare the 2 karyotypes and determine the sex of each one.

We find in the ovaries of a female drosophila the cells that undergo meiosis. The following figure represents several stages of this division.

- 2-1. Identify the cell that represents an abnormal chromosomal set.
- 2-2. Formulate a hypothesis to explain the origin of this anomaly.
- 3- Classify the diagrams in chronological order related to the meiosis stages. Justify.

An appropriate technique is used to measure the quantity of DNA in these cells while undergoing their divisions. The following table shows the variation of the amount of DNA as a function of time in these cells.

- 4-1. Convert the result obtained into a graph.
- 4-2. Explain the cause of the change in the DNA quantity between days 3 and 5.
- 4-3. Compare the quantity of DNA on the 5<sup>th</sup> day and on the 12<sup>th</sup> day; how much should the quantity of DNA be at day 12? Justify your answer.
- 4- Referring document 2, explain the cause of appearance of such abnormal value.

Time (days)	0	3	5	10	10.5	11.5	12	20	30
Quantity of DNA(a.u)	7	7	14	14	7	7	5	5	5

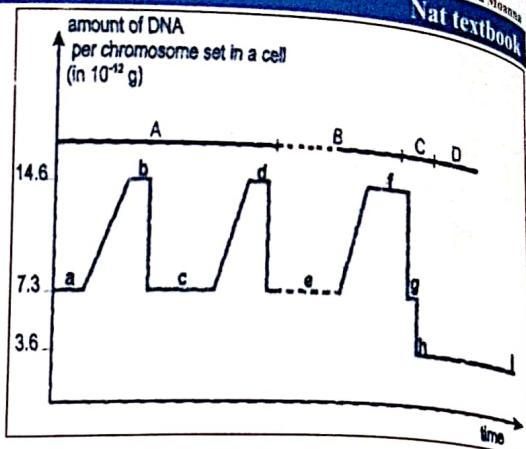
**Question-7-****Spermatogenesis**

The figure below shows the variation of the DNA quantity in the human germinal cell lineage as a function of time.

- 1- Which stage of spermatogenesis does each of the letters A, B, C and D represent?

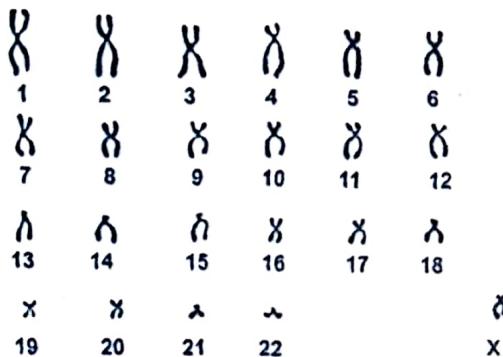
- 2- Name the cells obtained at the end of every stage.

- 3- Indicate the number of chromosomes and the number of chromatids per chromosome at every horizontal segment (from a to i). ( $2n = 46$  in the human species).

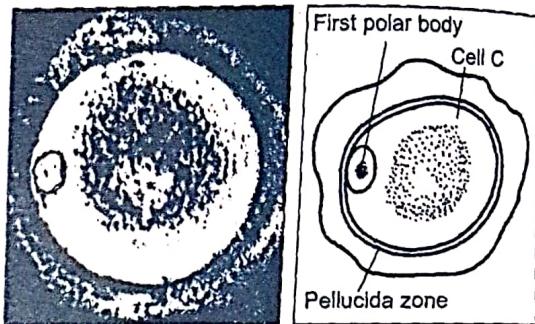
**Question-8-****Karyotype Analysis.**

Σ Updated

Figure-1 represents the karyotype of a female sex cell (C) and figure-2 is a photograph accompanied by an interpretation diagram of this cell.



■ Figure 1:  
Karyotype of a female sex cell.



■ Figure 2:  
Photo and diagram of a sex cell

- 1-1. Is this sex cell haploid or diploid? Justify the answer.

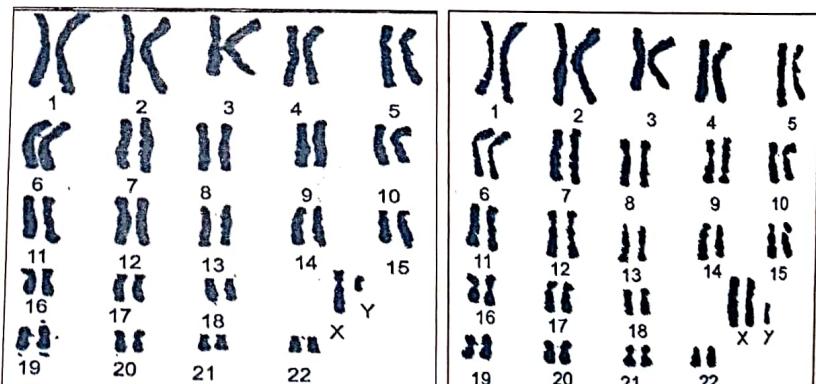
- 1-2. At what maturation time is this cell photographed? Justify, and say from which cell is it derived?

**Analysis of karyotypes:**

Docs 2 & 3 respectively represent human karyotypes.

- 2- Are these karyotypes for somatic or sexual cells? Justify your answer.

- 3-1. Specify the anomaly present in one of these two karyotypes.



- 3-2. By what mechanism can this anomaly be obtained? Explain.

To help you in answering such question, we will orient your answer by suggesting two possibilities: Either during spermatogenesis or Oogenesis.

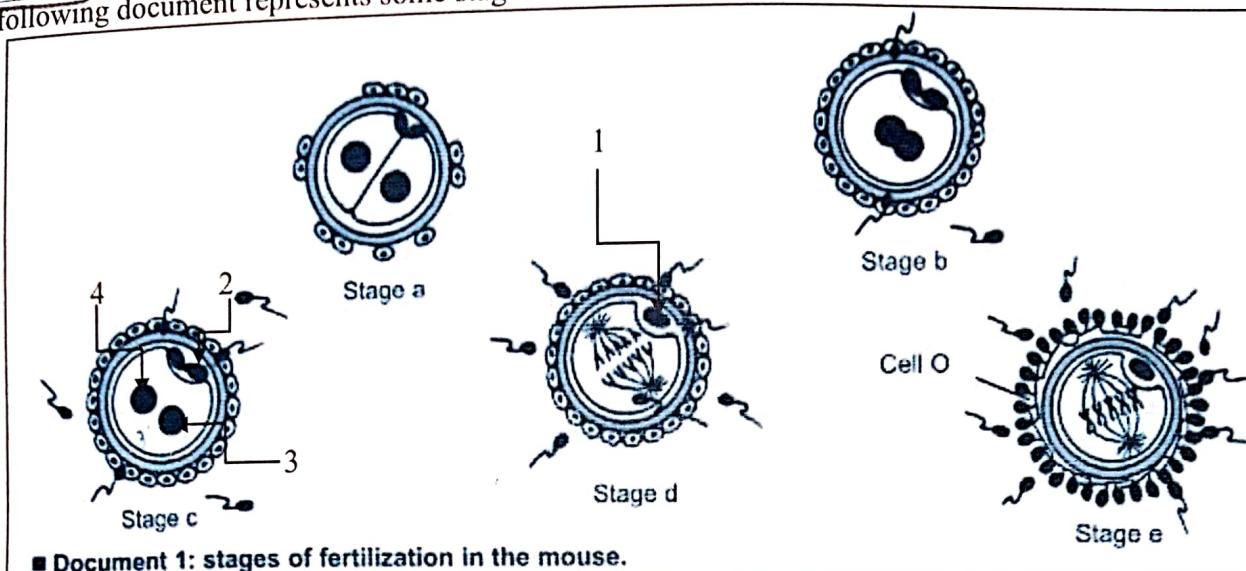
- 3-3. Illustrate, the process of oogenesis & spermatogenesis that lead to the abnormal zygote (karyotype- doc-3).

**Note-1:** The anomaly took place in spermatogenesis.

**Note-2:** Use, for your demonstration, chr-2 & 15 in addition to the involved chr.

**Part 1 of 4: Genetics  
Question-9-****Chromosomal Cycle, Stages of Fertilization & Abnormalities.**

The following document represents some stages of fertilization of a mouse.



■ Document 1: stages of fertilization in the mouse.

- 1- Label the elements 1 to 4.
- 2- Give a title to each stage and classify them in a chronological order. Justify your answer.
- 3- The elements 1, 2, 3 and 4 are haploid; define this term,

The quantity of DNA in the element-1 is double with respect to that found in the structures (2, 3 & 4).

- 4- Explain this difference (Answer using a labeled schema, using one pair of chromosomes only).

The table below shows the evolution of the total value of DNA, as a function of time, that the cell 0 contains during the successive events expressed in doc-1.

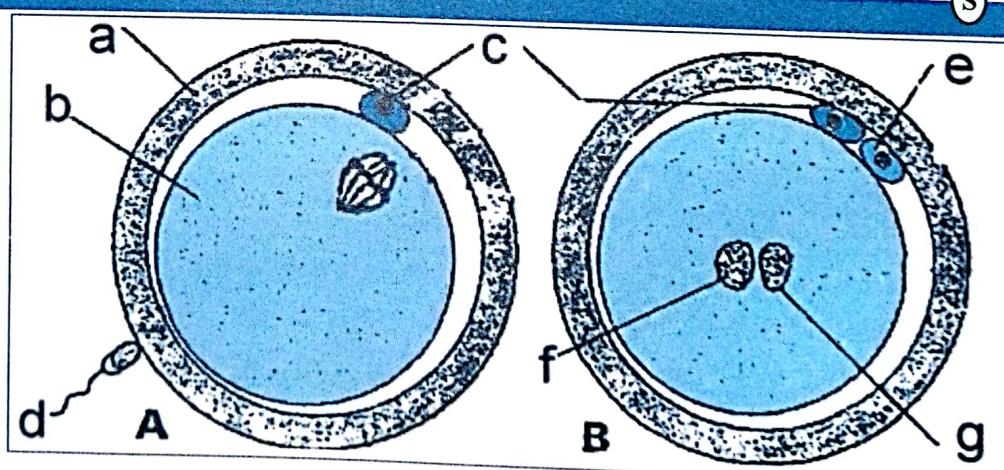
Time (in hours)	0	1	1	4	4	8	12	14	18	18	22
Quantity of DNA (in pg)	6.5	6.5	9.75	9.75	6.5	6.5	13	13	13	6.5	6.5

- 4- Construct the curve that translates the evolution of the value of DNA in cell 0 and indicate the different stages represented in document 1.
- 5- Referring to the documents and the acquired knowledge, explain the variations of the value of DNA and the modifications of the chromosomal garniture during the different stages of fertilization in the mouse.

**Question-10-**

The adjacent document shows an important biological process.

- 1- Name this process.
- 2- Name cells A & B. Justify.
- 3- Situate these two cells in the oogenesis. Justify.
- 4- Label the letters a to g.
- 5- Indicate the number of chromosomes and the number of chromatids for cells A & B & for the cells c, d and e and the structures f and g.
- 6- Referring to your acquired knowledge; explain the biological steps that occur during the passage of the cell from the state A to the state B.



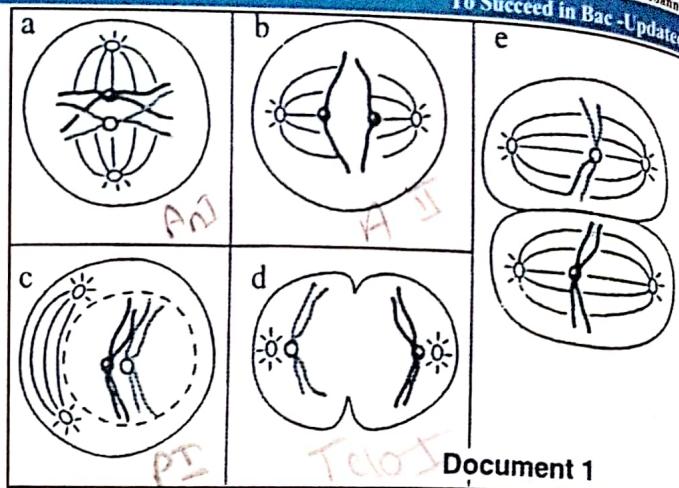
**Question -11-:**

The document below represents some important phases of meiosis that are observed during spermatogenesis.

- 1- Classify these different phases of meiosis in chronological order. Justify your answer.

A spermatocyte ( $2n=6$ ) undergoes meiosis.

- 2- Indicate the different possible chromosomal formulas of spermatids obtained in human species.



To Succeed in Bac - Updated

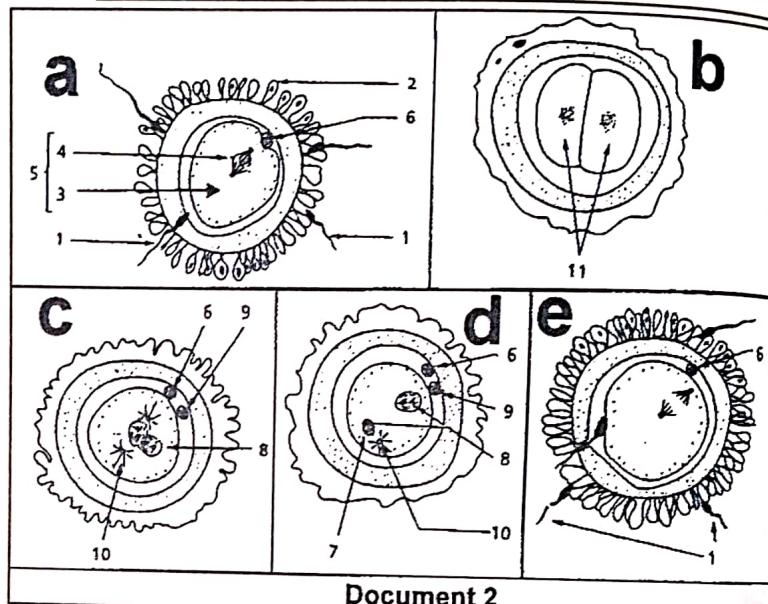
**(S)**

The following document shows certain stages of a biological phenomenon in human reproduction.

- 3-1. Name this phenomenon.

- 3-2. Label structures 1 to 11 in document 2.

- 3-3. Give the chronological order of the different stages of this phenomenon. Justify.

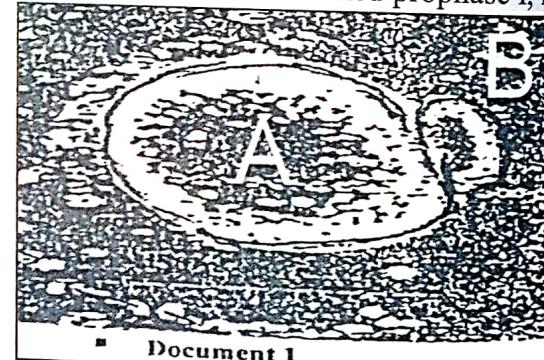


Document 2

**Question -12-:**

During follicular development: oocyte I dissociates from the cells surrounding it and it is liberated in the follicular cavity. A short time before ovulation, the first meiotic division, which is blocked prophase I, is unblocked, ends and results in two cells. Doc - 1 shows an electronography of the two cells just prior to ovulation.

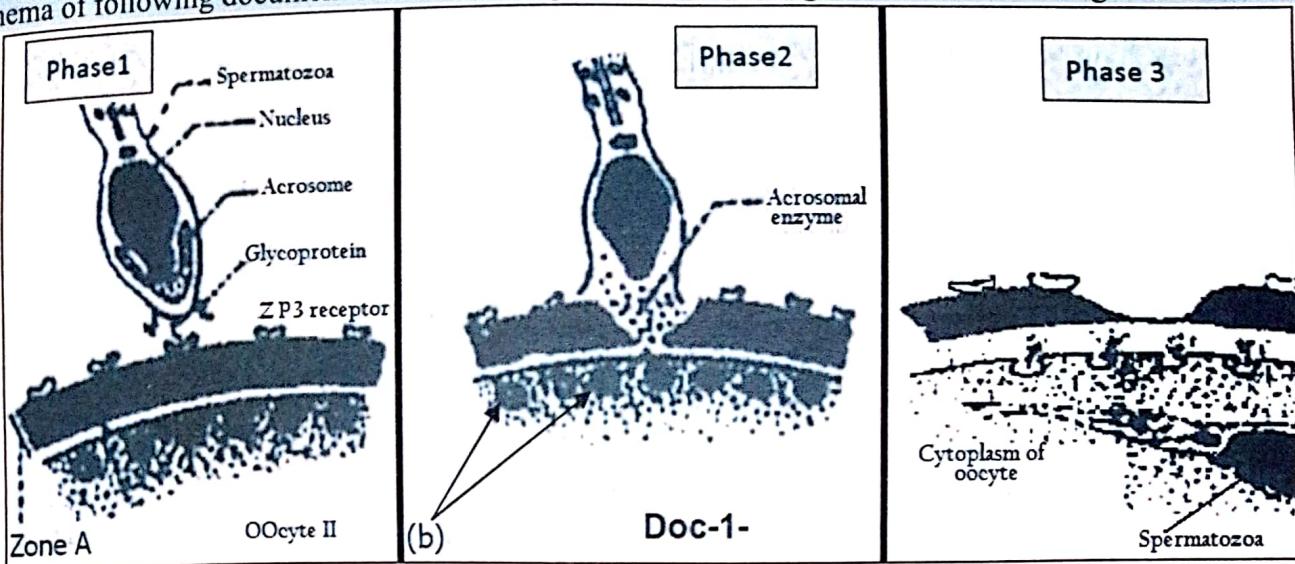
- 1- Name these two cells. Are they haploid or diploid? Justify.
- 2- Draw a simplified scheme of the meiotic division which was at the origin of such cells. Take into consideration one pair of chromosomes only.
- To study the conditions which permit the continuation of meiosis the following experiments are realized:
  - ❖ **Experiment 1:** Oocyte I cultured alone (without its surrounding follicular cells) meiosis continues.
  - ❖ **Experiment 2:** Oocyte I cultured in contact with its surrounding follicular cells meiosis remains blocked at prophase I.
  - ❖ **Experiment 3:** Oocyte I cultured with theca cells only, meiosis continues.
  - ❖ **Experiment 4:** We prevent LH increase, follicular cells surrounding oocyte I don't dissociate. Oocyte I keep blocked at prophase I.
- 3- Interpret the results of these experiments; derive a conclusion concerning the conditions that permit the continuation of meiosis.



Document 1

**Question-13-**

In-vitro fertilization experiments allow us to understand the aspects of sterility noticed in mammals. The schema of following document shows some aspects of the meeting of male and female gametes:



1-1. Specify zone A, structure b, and the phases 1, 2, and 3.

1-2. In certain cases of sterility, they note that stage 2 never comes true. How to explain this anomaly?

In other cases they even do not notice stage 1. To explain this last anomaly, from the zone A of an oocyte of mouse they isolated a molecule, that they identified as being a protein (receptor) & it was called ZP3. Molecules of radioactive ZP3 are put in the presence of spermatozoon of mouse. They notice that the radioactivity located on the surface of the head of spermatozoon, in contact with its plasma membrane.

2- Formulate a hypothesis to explain the role of ZP3 in fertilization.

The table below sums up conditions and results of experiments of in vitro fertilization done on mice. In all the experiments below the oocyte is taken just before ovulation.

3- Interpret these experiments, then conclude if your hypothesis is validated.

	<b>Experiments</b>	<b>Results</b>
exp.1	spermatozoa undergoes capacitation      ↓      oocyteII      ↓	Fertilization is done
exp.2	spermatozoa undergoes capacitation      ↓      Zone A isolated from an oocyte      ↓      Then mix with      →      oocyteII      ↓	No fertilization
exp.3	spermatozoa undergoes capacitation      ↓      Zone A isolated from Fertilized ovum      ↓      Then mix with      →      oocyteII      ↓	Fertilization is done
exp.4	oocyteII      ↓      Element b isolated from an oocyte      ↓      Then mix with      →      spermatozoa undergoes capacitation      ↓	No fertilization

4- Indicate the role played by element b during fertilization.

**Question-14-**

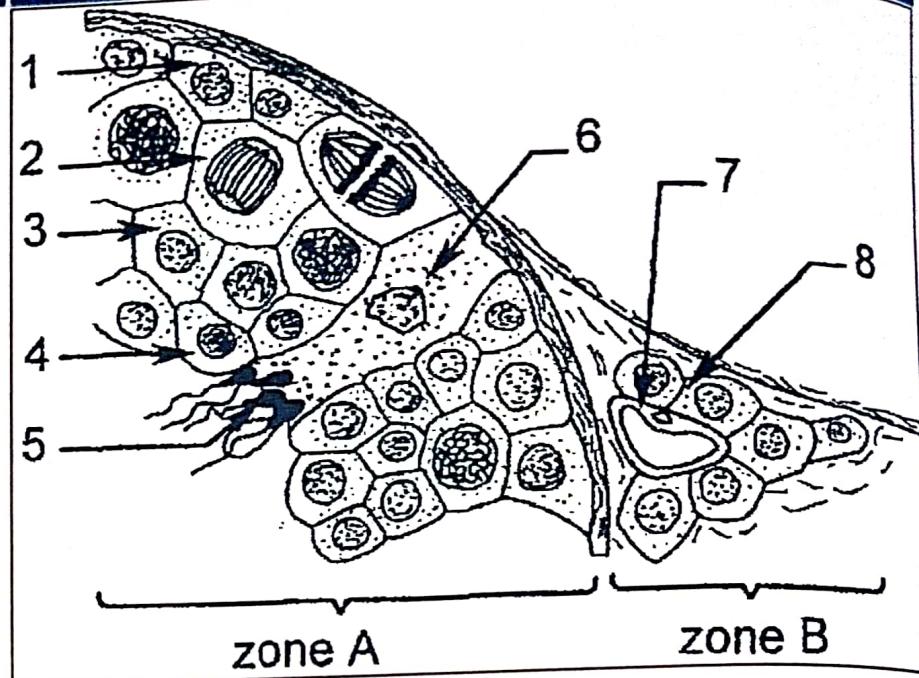
A study is done on certain aspects of reproductive functions in human species.

Document-1 represents a simplified cross section in a testis of a human male.

**Doc-1-**

- 1- Label the two represented zones.

- 2- Annotate 1 to 5 then 7.

**Reproductive Function of the Testicles.**

- 3-1. Name the process that allows the transformation from structure 1 to 5.

- 3-2. Indicate the number of chromosome and chromatids for these structures.

Consider the following two experiments.

<b>Exp.1</b>	<b>Destruction of cell 6</b>	<b>Cell 1 couldn't change into cell 5</b>
<b>Exp.2</b>	<b>Destruction of cell 8</b>	<b>Lack of testosterone secretion.</b>

- 4- Determine the type of each of cells 6 & 8.

To confirm the role of the testicles in reproductive function, experiments were realized on two lots of mice: lot-1 and lot-2. The experiments and their results are summarized in Document-2:

Lot	Experiments	Results
1	Zone- A was destroyed by X-rays	Sterility + Maintenance of the secondary sexual characteristics.
2	Zone- B was destroyed by X-rays	Sterility + Regression of the secondary sexual characteristics

- 5- Interpret the obtained results.

- 6- Based on the given information and referring to your acquired knowledge, give two possible causes of sterility in men.

## Human Sexual Reproduction

Part-1 of 4 - Genetics

**Question -15-**

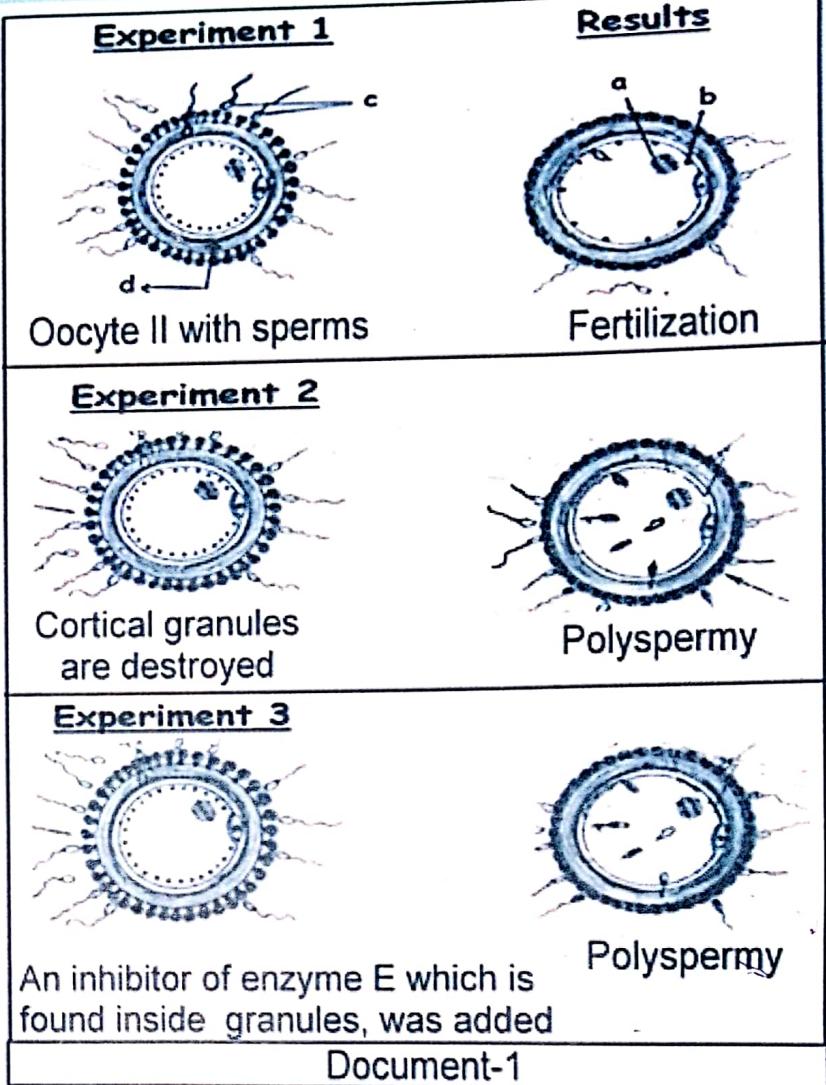
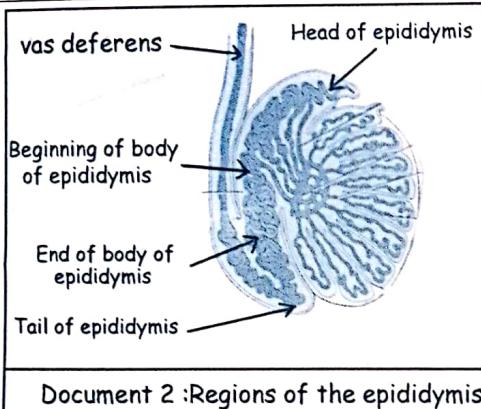
A. In order to study the process of fertilization, several experiments are performed in vitro on oocyte II at metaphase II and sperm cells. The conditions of some of these experiments & their results are shown in doc 1.

1- Label a, b, c & d of exp.1.

2- Explain the result of experiment 1 & the nuclear changes that will take place at the level of oocyte II & sperm cell.

3- Interpret each of the experiments 2 & 3.

In the seminiferous tubules of the testicles of a sheep, sperm cells are immobile. During their transmission along the regions of the epididymis, document 2, three types of sperm cells are observed with different aspects of movement, as shown in document 3.

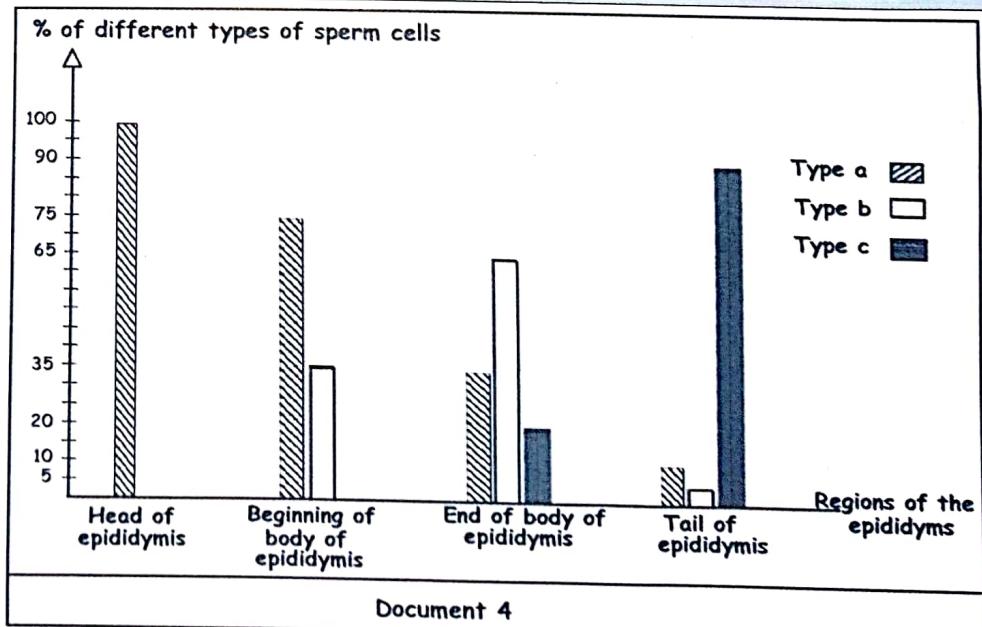


- ✓ **Type a :** The flagellum of the sperm cells oscillates without any displacement (change of place).
- ✓ **Type b :** The movement of the sperm cells is disordered (sperm cell turns around itself).
- ✓ **Type c :** The flagellum makes a surfing movement & sperm is motile and can progress forward.

**Document 3**

Document 4 shows the % of different types of sperm cells as a function of the region of the epididymis.

- 4- Represent the data of doc-4 in a table form.
- 5- Interpret document 4 (taking into consideration the information provided by doc 2 & 3). Conclude the role of epididymis.



**Question -16-**

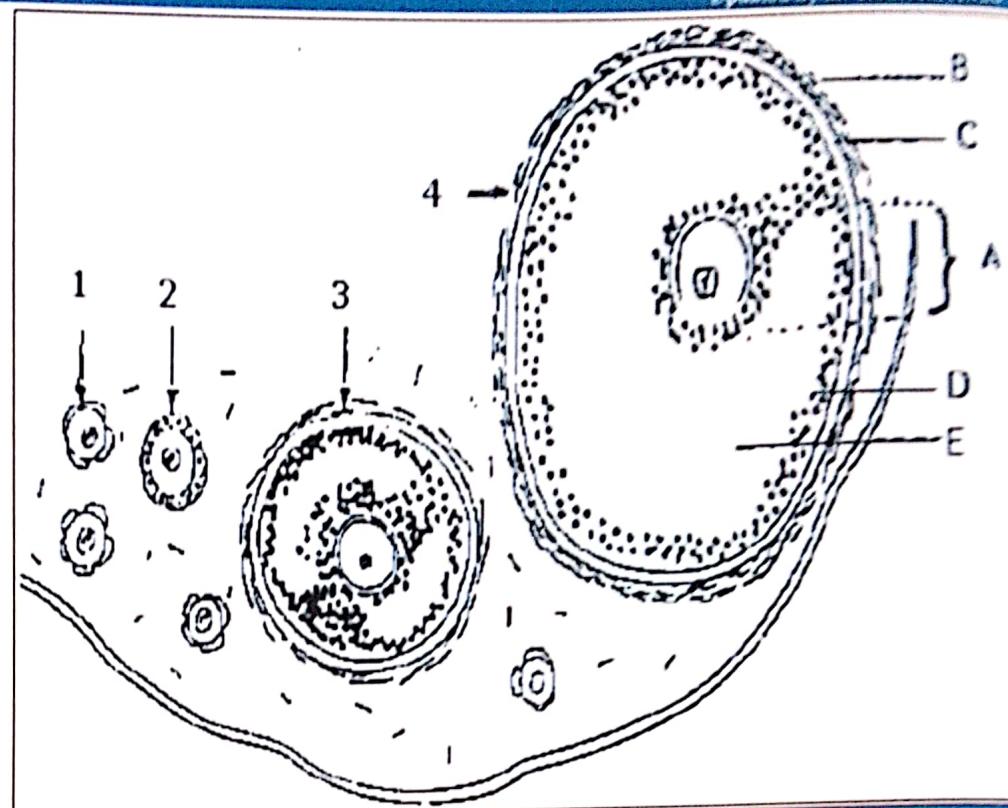
Document 1 is a diagram of a cutting portion in an organ of the genital tract in women.

Referring to doc-1:

1-1. Indicate the name of the organ observed.

1-2. Label the structures (1 to 4) & letters (A, B, C, D and E).

1-3. Identify which phase of the sexual cycle, this cut was made?



**Doc-2:** Photograph of the structure A (doc. 1) but after fertilization.

2- Using your acquired knowledge, list four structural differences of the component A between documents 1 & 2.



In order to study aspects of reproductive function in humans, you propose to use certain data: Document 3 has a portion of cross section of human testis.

3- Label the structures 1 to 8.

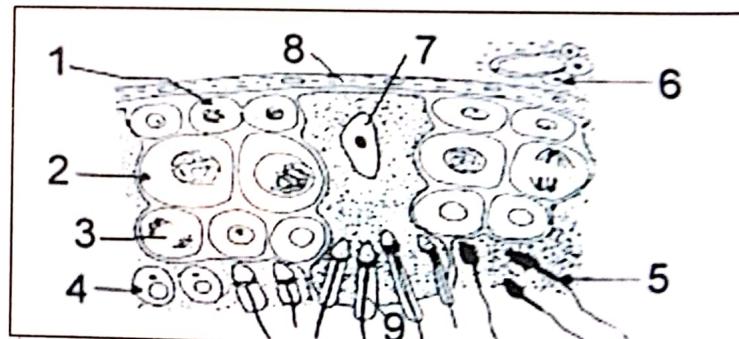
4- State the number of chromosomes & chromatids for cells 1 to 5.

5- Name the process (phase or division) that allows the formation of cell 2 and cell 4.

6- State the function of each cell 6 & 7.

7- Give the four structural modifications that allow the transformation of cell 4 to cell 5.

8- Cell 9 is inactive; draw out the reason of this inactivity.



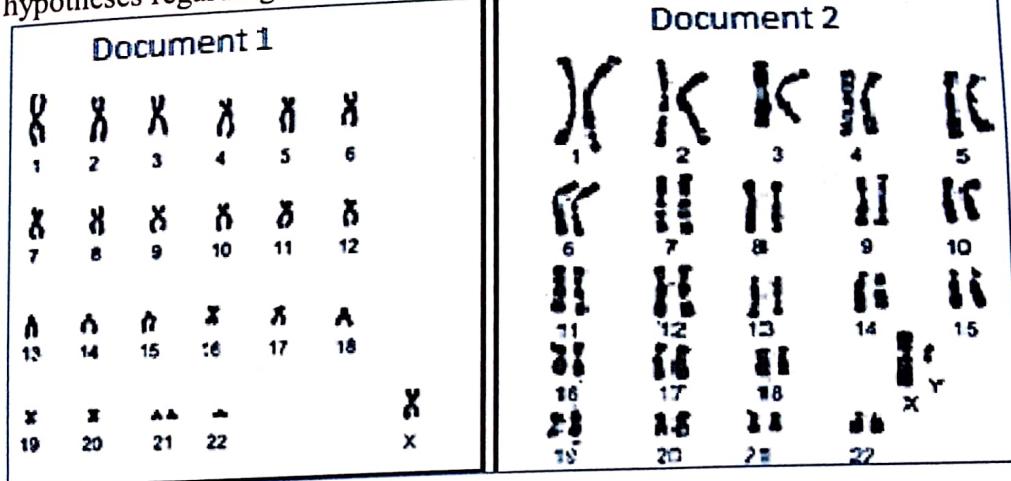
**Question-17-****Origin of Chromosomal Abnormality**

After giving birth to a baby with chromosomal abnormality the doctor usually recommends performing karyotype analysis for each of the parents to find if there is any chromosomal abnormality in the parents' cells or if the abnormality was due to non-disjunction in the meiosis during gamete formation which usually takes place by chance.

1- Pick out from the text two hypotheses regarding the origin of chromosomal abnormality in the baby.

Couple X had a child with Trisomy 21. Documents 1 and 2 are the result of the karyotype for two cells which were removed from the seminiferous tubules of MR. X.

- 2-1. Name these two cells and precise to which phases of the spermatogenesis they belong.



- 2-2. Indicate the abnormality in document 1.

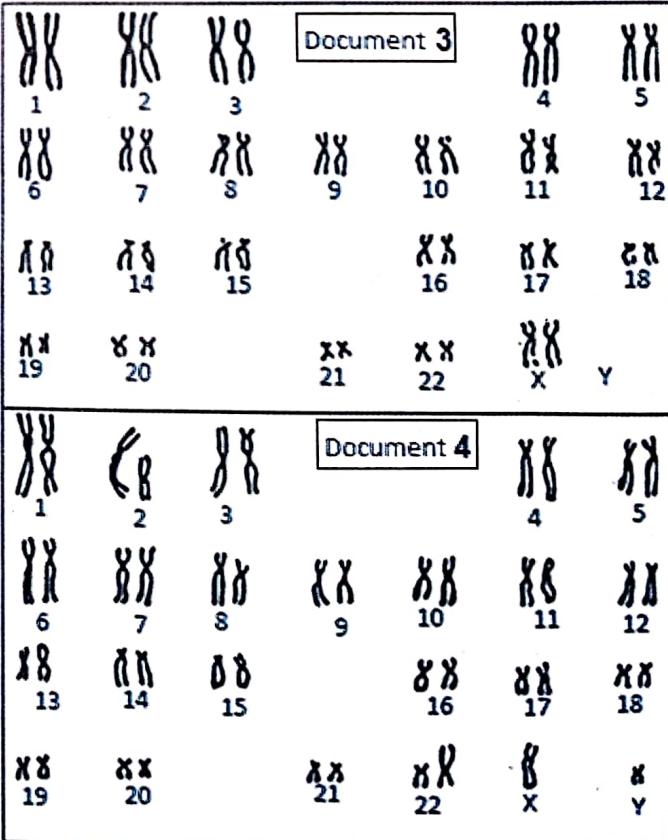
- 2-3. By limiting to the sexual chromosomes and to the chromosomes 21, schematize the biological process that occurs resulting in cell of document 1 (from spermatogonium till spermatocyte II).

Another normal couple Y had an abnormal child. Their karyotypes are shown in documents 3 and 4.

- 3-1. Determine the person that has abnormal karyotype; how can you explain his normal phenotype?

- 3-2. a. Schematize the process of meiosis in the person with abnormal karyotype.  
b. Calculate the probability for them to have an abnormal child. (limit yourself to the abnormal chrs)

- 4- Deduce which hypothesis was verified in each couple.

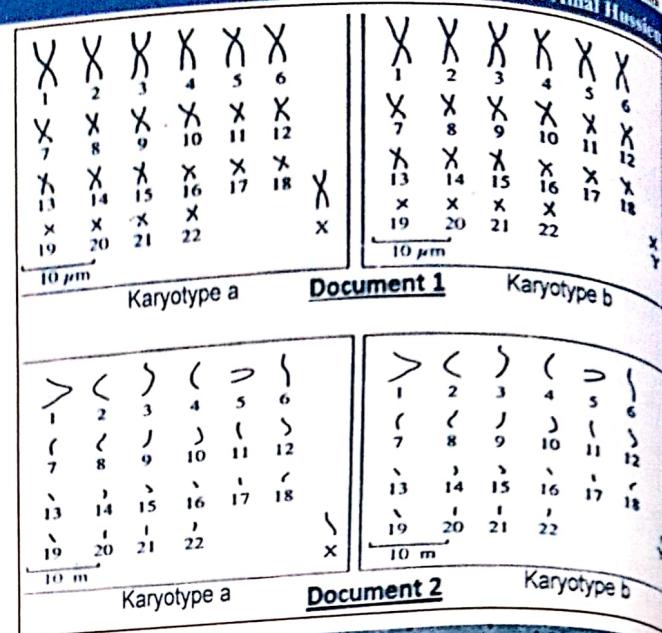


**Question - 18:**

**Rare male sterility**  
 A doctor wishing to know the cause of the infertility of Mr. X. He submitted Mr. X to several reviews: such as karyotyping for his spermatocytes (Doc-1) & spermatozoa (Doc-2). He Obtained 50% of the cells representing Karyotype a & 50% of karyotype b.

1- Draw an annotated figure of spermatogenesis showing the quantity of DNA at each phase. Limit your draw to pair 1 & sexual chromosomes.

2- Specify the phase of spermatogenesis in which karyotypes of document 1 & 2 correspond.



-Sperm cells observed under electronic microscope showed an abnormal constitution.

3- Compare both sperm cells; conclude the cause of abnormal constitution of sperm cells.



4- Name the abnormal phase of spermatogenesis at the origin for producing such abnormal sperm cell.

A specific study has shown that this anomaly called "**Sperm Globozocephaly**", characterized by the production of round head sperms which are unable to fertilize the ovum.

This anomaly has helped researchers to identify an absence of 200,000 pairs of bases in 1 or even 2 identical alleles of the gene DPY19L2. This gene is necessary for the elongation of the sperm and the formation of the acrosome.

The loss of this genetic sequence is the result of a "non-allelic homologous recombination" during meiosis, the division that produces two sex cells from a germ cell, the homologous chromosomes will exchange DNA sequences. Such exchanges contribute to the evolution of our species. But they do sometimes occur from homologous sequences located at different locations in the genome, which may lead to duplications and deletions of genes as in the case of the globozocephaly.

5- 5-1. Indicate the type of mutation. Is it beneficial in this case? Justify.

5-2. Explain why this mutation had extended for 200 000 bp.

5-3. Knowing that sperm cells couldn't be fertile if they are deprived of acrosome; what is the role and the origin of this latter?

5-4. Name the process of exchange mentioned in the given text. How could it contribute to the evolution of our species? [solved only after chapter 2]

Researchers try to propose a remediation (cure- therapy) for patients with sperm globozocephales. On the other hand, it is thought that by blocking the action of the protein coded by the gene DPY19L2 we could prevent the formation of fertile sperm for some times under request. (Use as a contraceptive method).

6- Suggest a possible therapy for this anomaly.

**Question 19:** In general, human karyotype is characterized by stability; this is to say having a constant number of chromosomes ( $2n=46$  chr.s).

To understand the mechanism and the origin of stability and instability of human karyotype, we refer to the analysis of documents 1 and 2.

Document 1 shows a specific structure removed from the female's genital system.

- 1- 1-1. Give a title.

- 2- Using your acquired knowledge:

- 2-1. Is it haploid or diploid? Justify.

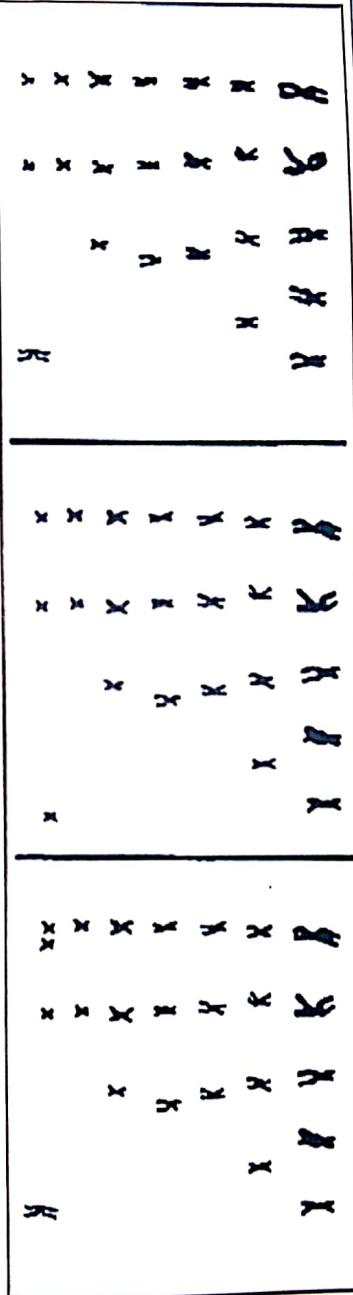
- 2-2. Is it fertilized or not? Give two evidences.

- 2-3. Name the stage in which structure 3 & 4 mix.

- 2-4. Indicate the meiotic phase currently taking place.

- 2-5. Verify if both cells labeled (2) have the same number of chromosomes.

3- Document 2, composed of the figures a, b and c respectively, which corresponds to the possible karyotypes of the elements 3 & 4 indicated in document 1.

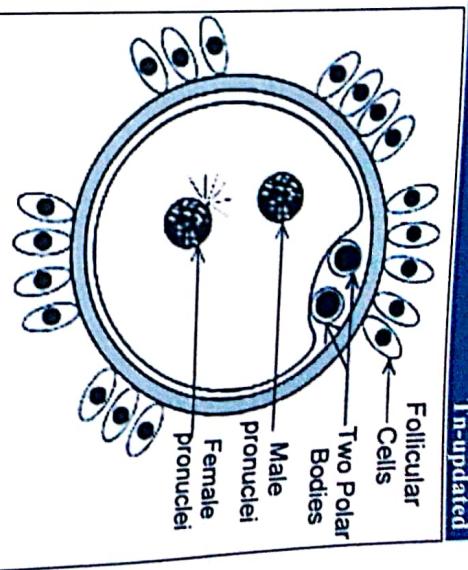
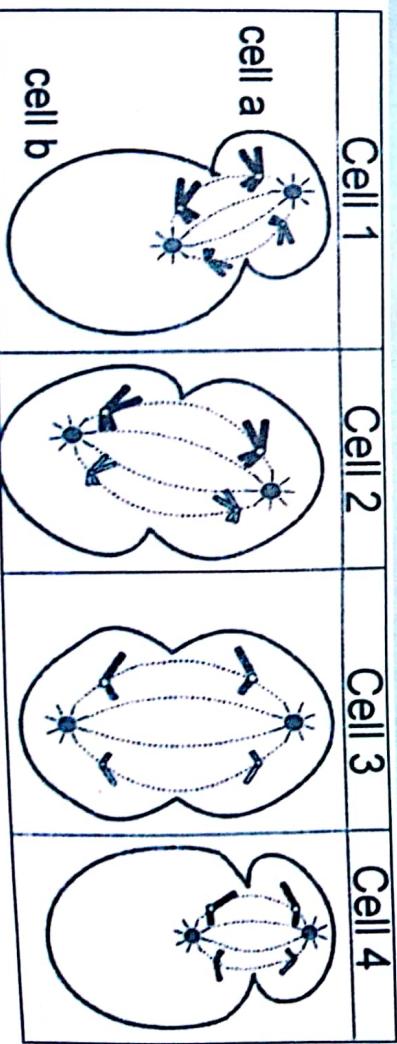


### Document 2

- 3-1. Referring to document 2, identify to which element (3 or 4) does each of the karyotypes a, b, and c correspond.
- 3-2. Explain, by using schemes, the mechanism which leads to the formation of karyotype c. (to simplify the schemes, represent the cell with  $2n = 6$  chromosomes).
- 4- Referring to all what precedes, and based on your acquired knowledge, explain the mechanisms responsible for the stability and the instability of the human karyotype.

**Question - 20:** Document 1 shows simplified schemes of four sexual cells donated as 1, 2, 3 and 4 in division in the course of gametogenesis.

- 1- Identify each of the given sexual cells.
- 2- Referring to your knowledge, precise the possible or certain fate of each of the daughter cells a & b of cell 1.



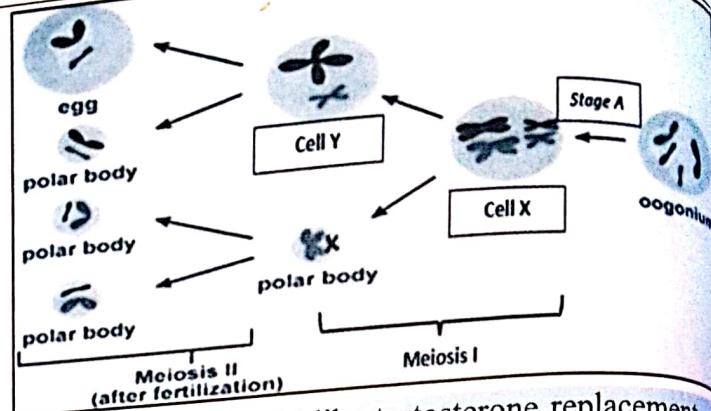
**Part-1 of 4 - Genetics****Question - 21:**

Meiosis is the process by which gametes are formed & is called gametogenesis. Literally "creation of gametes".

- Fill in the blanks with the appropriate word.
- Meiosis is of 2 divisions: one that produces cells of "n" chromosomes of 1 chromatid and is called (1)..... division and the other that produces "n" chromosomes of 2 chromatids and is called (2)..... division. The specific type of meiosis that forms sperm is called (3)..... while the formation of egg cells, or (4)....., is called (5).....

**Document 1: Ova Production.** Figure 1 shows in brief the process of production of ova. →

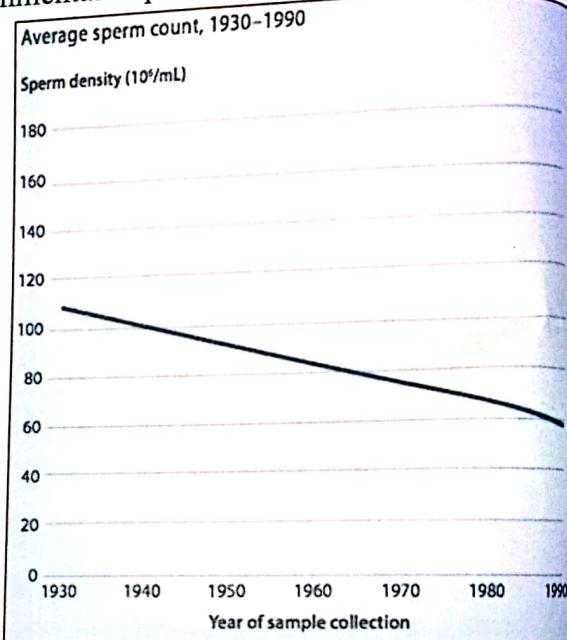
- Name cells X and Y, and indicate stage A.
- Describe figure 1 in few lines.
- Will the female use the polar bodies formed? What will happen to them then?

**Document 2: Sperm production.**

In men there are several known risk factors for infertility: Medications like testosterone replacement or some cardiac drugs, long term alcohol use, smoking, environmental exposure to chemicals, heat such as saunas or hot tubs and plenty more.

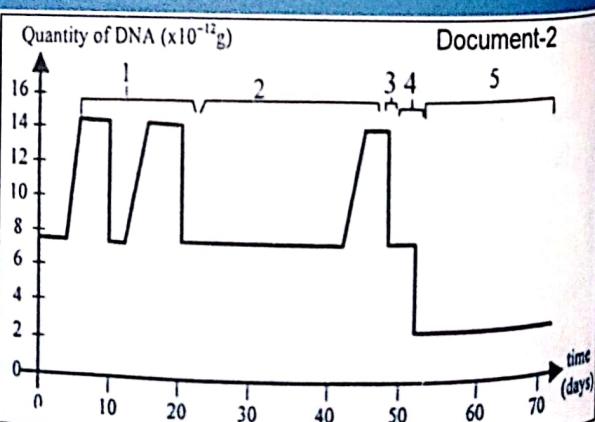
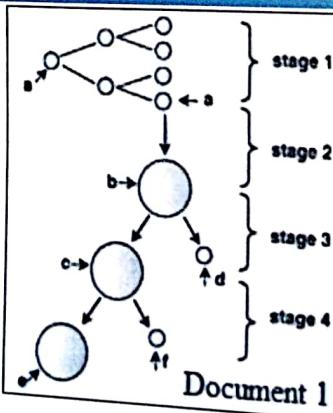
For that, a study has been conducted to compare the average sperm density in men throughout a period of time. Note that if the sperm density is lower than  $30 \times 10^6$  ml, then the man is more likely to have male infertility that can be healed by staying away of its causes. The results are shown in figure 2.

- Interpret the graph of figure 2.
- Mrs. Z was trying hard to have a baby but with no result. All the tests indicated that she is normal.
- Referring to the graph & the text, formulate a hypothesis to explain why Mrs. Z is not getting pregnant.
- Mr. Z, known to be an alcoholic diagnosed his sperm production and the results showed low sperm density (around  $25 \times 10^6$  /ml).
  - Is your hypothesis validated? Justify your answer.
  - Propose a method for Mr. Z to increase his sperm density during time.

**Question - 22:**

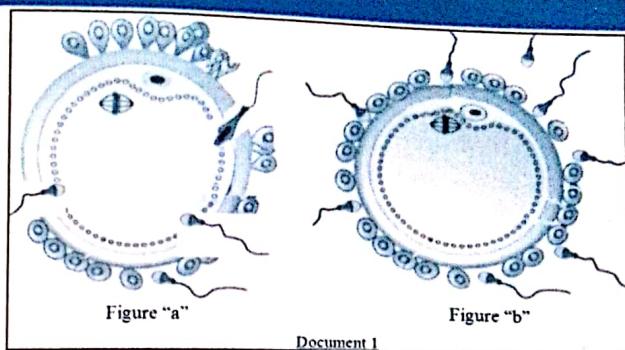
Document 1 presents the stages of oogenesis in a woman.

- Name the cells indicated by arrows.
- Name & describe briefly the different stages of document 2.
- Give the chronological differences and the difference in number between spermatogenesis and oogenesis in the human species.



**Question-23-**

In a fertility clinic two males has performed semen analysis. Male "A" is fertile while male "B" is sterile. A medical team in this clinic had made, in vitro, experiments to study the medical case of male (B). They brought healthy oocytes blocked at metaphase 2 of meiosis and place them with the semen of (A) and with the semen of (B) as in figure "a" and figure "b" of document 1 respectively. The results are shown after the same duration of time:



Document 1

- S** 1- 1-1. Based on your acquired knowledge, formulate two hypotheses to explain the cause of non-fertilization in figure "b".  
**S** 1-2. By referring to your acquired knowledge, indicate the different stages that follow figure "a" at the level of the oocyte and the sperm cell.

The results of semen analysis are shown in document 2 below:

Individuals	Number of sperm cells	Morphology of sperm cells	% of motility	% of fertility of sperm cells
Male A	> 40 million/ml	> 30% Normal	> 50%	> 60%
Male B	Bet 10 - 12 millions/ml	Between 20 to 65% Normal	<30%	<30%

- 2- Interpret the results of document 2.  
 3- Is one of the hypotheses validated? Justify.  
 In the frame work to know the cause of individual B abnormality, more detailed tests were performed and the results are presented in document 3: →  
 4- Based on the results of doc-3, determine the cause of sterility of individual B.

**Document 2**

Figure "a"	Figure "b"
Forward progression towards the oocyte is 70%	Forward progression towards the oocyte is weak
Presence of protein "f" in the flagellum	Absence of this protein in the flagellum

**Question – 24-****Male Sterility**

By Mr Ali Awad

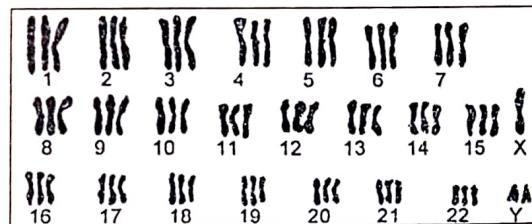
**A-Identification of a cell division:** In the seminiferous tubule we can observe the presence of two cellular divisions during spermatogenesis. The table below represents the variation of the quantity of DNA during these two divisions.

Time	$t_0$	$t_1$	$t_2$	$t_3$	$t_4$	$t_5$	$t_6$	$t_7$	$t_8$	$t_9$	
Quantity of DNA ( $\times 10^{-12}$ Kg)	Division A	7.2	7.1	7.1	14.2	14.2	7.1	7.1	7.0	7.1	7.1
	Division B	7.0	7.2	7.2	14.2	14.1	7.2	7.2	3.6	3.6	3.6

1. 1-1. Trace, on the same graph, the variation of the quantity of DNA during the two cellular divisions as a function of time (take 1 cm between two different times).  
 1-2. Identify each one of the two divisions.

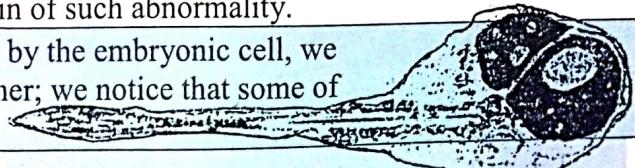
**B-Meiotic errors or disorders, fatal consequences.**

The following karyotype belongs to a cell taken from an embryo that was expelled after a spontaneous abortion:

**Document-1: Karyotype of the aborted embryo.**

2. 2-1. Give the chr. formula for the given karyotype.  
 2-2. What abnormality is shown or revealed by this karyotype?  
 2-3. Formulate 2 hypotheses that explain the origin of such abnormality.

In order to find the real cause of the abnormality shown by the embryonic cell, we observe under the microscope the sperm cells of the father; we notice that some of them present the following aspect:

**Document-2: Schema of an abnormal gamete.**

- 3- Referring to the schema shown in doc-2, deduce the real cause of the abnormality that has led to the abortion of the embryo. Justify your answer.  
 4- Illustrate the behavior of chromosomes, in both parents, during meiosis and fertilization that is at the origin of such an embryo.  
 5- Referring to your knowledge, concerning the mechanism of the fertilization process, mention one event or factor that inhibit the penetration of more than one sperm cell into the inside of the same oocyte.

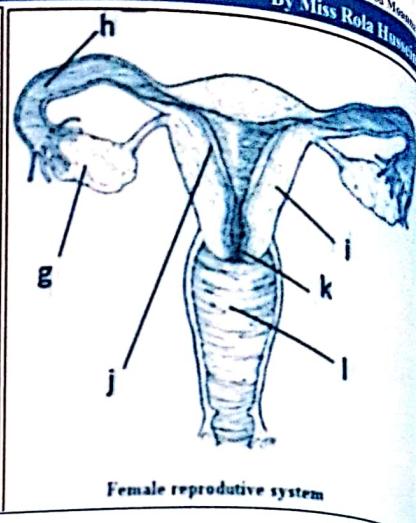
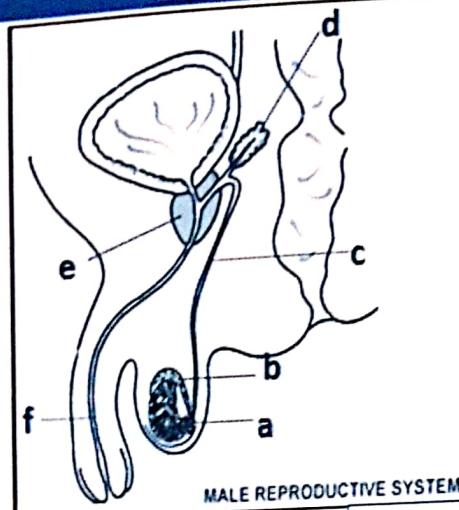
**S**

**Question -25-**

Reproduction is the process that ensures the survival of species. Sexual reproduction involves two individuals of opposite sexes and belonging to the same species. It necessitates the presence of a specialized and organized reproductive system.

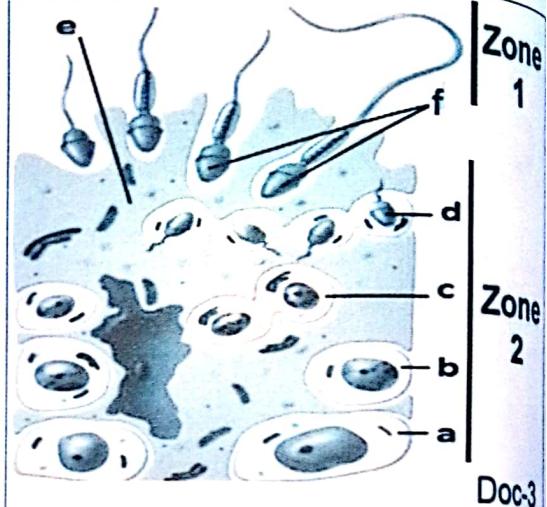
Documents (1 & 2) represent the male & female human reproductive systems.

**Sterility**



- 1-1. Label documents 1 and 2 (from a to l).
  - 1-2. State the function of organs a - c - d - h.
- 2- A section of a seminiferous tubule present inside organ (a) was viewed under the microscope. Document 3 shows a detailed view of this section.
- 2-1. Name the process revealed in this figure.
  - 2-2. Draw a table that shows the name of the cells a - b - c - d - e - f, the number of chr / cell & whether the chromosome is made up of 1 or 2 chromatids.

Two cells were taken from cells of document 3 & karyotyped. The results are shown in documents 4 & 5.



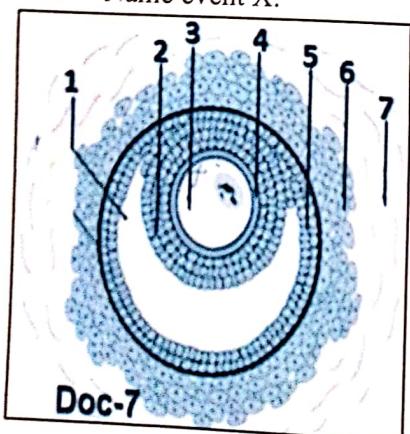
- 3-1. Compare the two karyotypes.
- 3-2. Specify to which cells of document 3 these karyotypes belong.
- 3-3. Schematize the biological process shown in document 3. Limit yourself to sex chromosomes and chromosome 21.

Document 4											
X	X	X	X	X	X	X					
1	2	3	4	5	6						
X	X	X	X	X	X	X					
7	8	9	10	11	12						
X	X	X	X	X	X	X					
13	14	15	16	17	18	X					
X	X	X	X	X	X	X					
19	20	21	22			X					

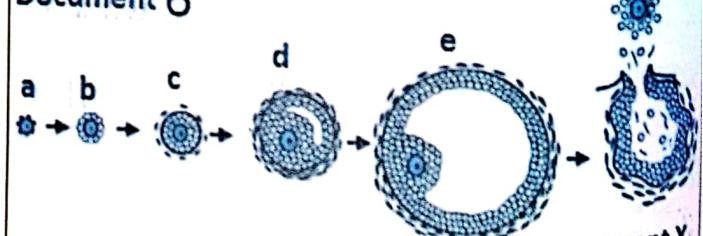
Document 5											
X	X	X	X	X	X	X					
1	2	3	4	5							
X	X	X	X	X	X	X					
6	7	8	9	10	11	12					
X	X	X	X	X	X	X					
11	12	13	14	15	16	17					
X	X	X	X	X	X	X					
18	19	20	21	22							
X	X	X	X	X							

Document 6 represents structures observed in a cross section of organ g in document 2.

- 4-1. Name structures (a - b - c - d - e).
- 4-2. Name event X.



**Document 6**



Doc-7 represents detailed schematic drawing of structure (e) in doc-6.

- 4-3. Label document 5 (1 to 7).
- 4-4. Schematize oogenesis. Given  $2n=6$ . (Chr 2, 12 & sex chr).
- 4-5. Draw a table that shows the different cells involved in oogenesis & the number of chr in the nucleus of each cell and the number of chromatids per chr.

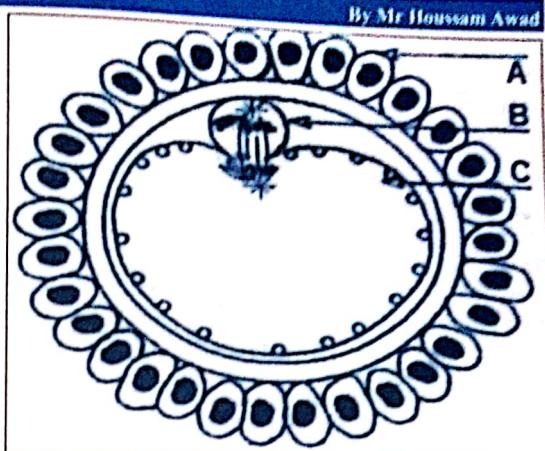
**Question-26-**

The document below illustrates a stage of the oogenesis among the women (to simplify, it has reduced the number of chromosomes  $2n=4$ ).

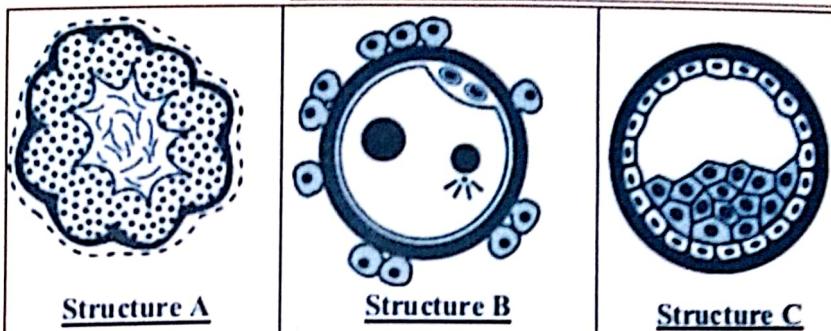
- Identify the stage represented by this document.

- Name the cells A, B and C. **(S)**

- Specify the time of the sexual cycle in which we can observe this stage.



The figure below represents the events occurring after ovulation.



- Complete the table below.

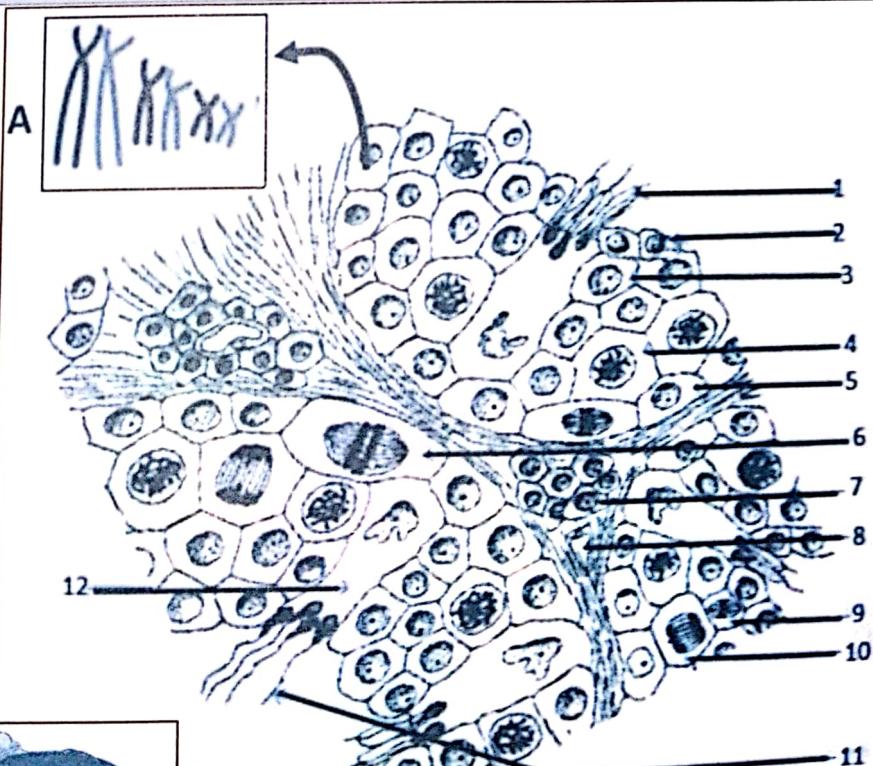
	Structure A	Structure B	Structure C
Name			
Site of observation			
Period of sexual life			
Event at the origin of each structure			

**Question-27-**

By Mr Houssam Awad

Document 1 is the schematic diagram of a section of a testicle of a mammal.

- Label document-1.
- Identify if this animal reach puberty or not.
- Illustrate by schema & starting from the cell designated by number 5, the steps leading to the formation of the cell number 11.
- Use the 3 pairs of chrs represented in A, represent the chromosomal lining in cells 2, 3, 4, 7 & 12. Justify.
- Doc-2 shows the electron microscopic observation element 11. Make a labeled diagram of this element.

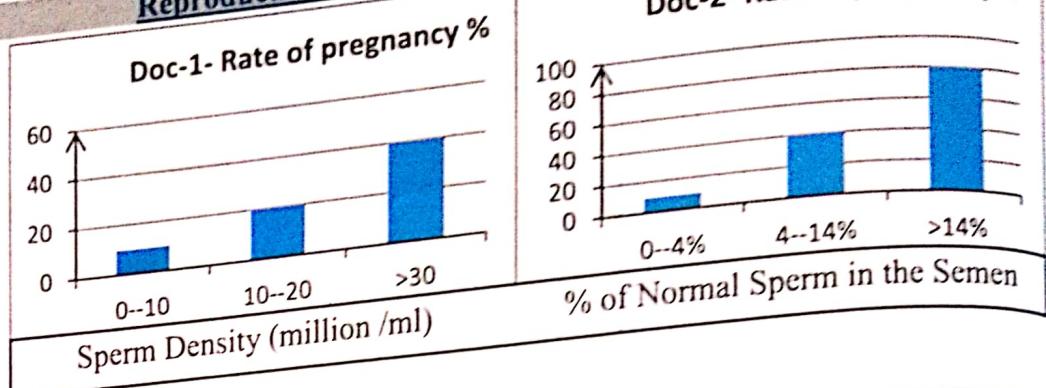


## Part-1 of 4 - Genetics

**Question-28-**

Document 1 represents the results of 2 studies which are performed to determine the factors affecting the male infertility.

(The pregnancy rate reflects the rate of male fertility).

**Reproduction and Male Fertility.**

- 1-1. Analyze the obtained results.

- 1-2. Draw out the factors which affecting the male infertility.

In men there are several known risk factors for infertility: medications, long term alcohol use, smoking environmental exposure to chemicals and heat such as saunas....note that if the sperm density in men is between 5 and 10 million /ml, the men are more likely to have male infertility that can be healed by staying away of its causes.

**Doc 2**

- Mrs Z which was trying hard to have a baby but with no result. All the tests indicated that she is normal. The sperm test of Mr. Z which is a chemist shows that its sperm density is around 12 million/ml.

- 2.1- Identify, using documents 1 & 2 , the cause of absence of pregnancy for Mrs.Z .

- 2.2- Propose a solution for the problem of family Z.

For another couple Y: Mrs. Y is exposed to spontaneous abortion after each pregnancy. To identify the problem, the doctor performed a karyotype of the aborted embryo; document 3 represents the obtained karyotype.

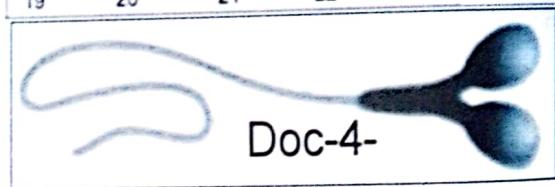
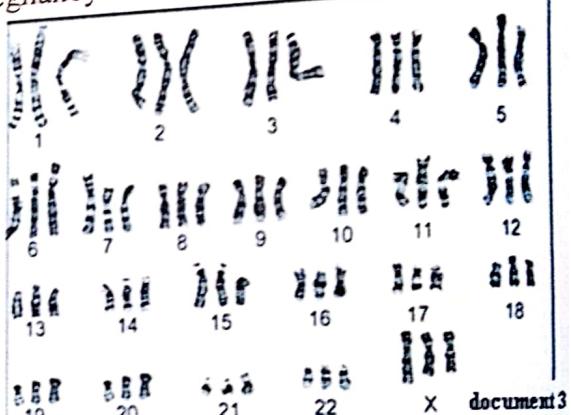
- 3- Indicate the chromosomal formula for this karyotype.

- 4- Indicate the abnormality that is revealed by this karyotype.

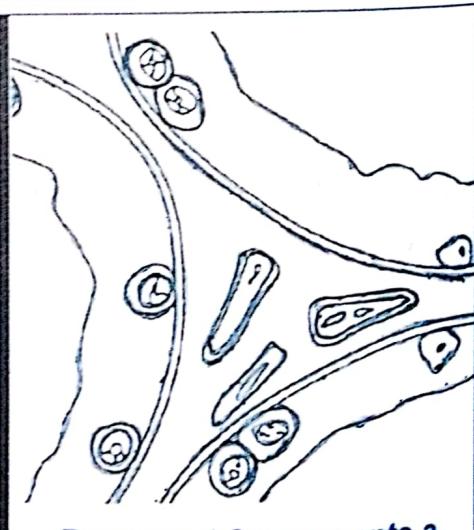
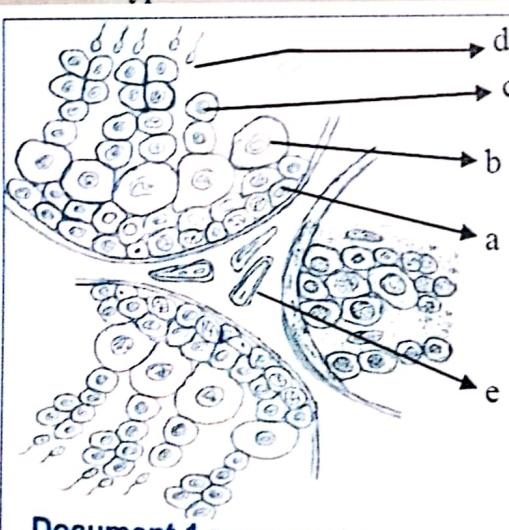
- 5- Formulate 2 hypotheses that explain the origin of such abnormality.

-In order to find the real cause of the abnormality shown by the embryonic cell, we observe under microscope the sperm cells of the father Y: we notice that they almost have the aspect represented in document 4:

- 6- Draw out from document 4, the real cause of the abnormality that has led to the abortion of the embryo.

**Question-29-**

Cryptorchidism is an anomaly that affects males of mammals (specially humans) reaching adulthood if their testes were developed in the abdominal cavity instead migrate into the scrotum (or scholars), locates outside abdomen. Some secondary sexual characteristics are manifested in a cryptorchid but it is sterile.

**Cryptorchidism**

- Part 1 of 4 : Genetics  
 1- Name the phenomenon that occurs in doc 1; at what age begins & when it stops?  
 2- Label the structures a to e.  
 3- Compare documents 1 & 2.  
 4- Using doc 1, 2 & your knowledge, explain why a cryptorchid is sterile, but it may develop secondary sexual characteristics.

### Semen analysis

#### Question-30-

In a fertility clinic 4 males performed semen analysis the results are shown in the documents below:

Male (A) is normal, he performed routine semen analysis. The results are presented in document (1):

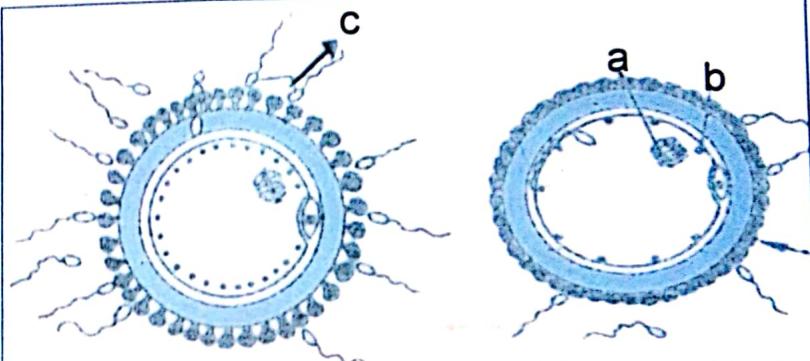
Document-1	Forward progression towards oocyte	% Motility	Morphology of sperm cells	Number of sperm cells
Fertility				
> 60%	Present	> 50%	> 30% Normal	> 40 million/ml

Male (B) is infertile, document (2) shows the semen analysis as recorded in the clinic:

Document-2	Forward Progression towards oocyte	% Motility	Morphology of sperm cells	Number of sperm cells
Fertility				
< 30%	Not present	< 30%	Between 20 to 65% Normal	Between 10 to 12 million/ml

- 1- Compare the semen of males A & B.

A medical team in this clinic had done in vitro experiments to study the medical case of male (B). They brought healthy oocytes blocked at metaphase 2 of meiosis and place them with the semen of (A) and with the semen of B as in Fig(a) and Fig(b) respectively:



The results of observation of the two experiments are recorded in the following document 3 as seen below:

Doc-3-	Figure (a)	Figure (b)
Efficiency of movement and fertilization is 70%		Efficiency of movement and fertilization is null.
Forward progression towards the oocyte is 70%		Forward progression towards the oocyte is null.
Hyperactive sperms		Hypoactive sperms
Presence of protein called catsperm in the flagellum		Absence of this protein in the flagellum.

- 2- After analyzing Figures a & b, conclude the cause of infertility of male (B) & the role of protein catspem.  
 3- Referring to your knowledge, indicate the changes that follow Fig(a) at the level of oocyte & spermatozoon.  
 4- Label a, b, and c (of Fig. a and b).

Male (C) is infertile the following document represents the results of semen analysis.

Doc-4-Fertility	Forward Progression towards oocyte	% Motility	Morphology of sperm cells	Number of sperm cells
< 30%	Slightly found	< 30% moves normally	< 30% normal sperms Presence of sperms with two heads	Between 12 to 13 million/ml

- 5- What hypothesis you can formulate concerning the cause of infertility of male(C).

- 6- Explain, by referring to spermatogenesis, how would the abnormal sperm cells (with 2 heads) of male (C) be formed.

Male (D) is exposed to vasectomy, the vas deferens on each side is sectioned and the cut ends are tied thus preventing the release of spermatozoa from testes. The results of the semen test are recorded in document 5.

Doc-5-Fertility	Forward Progression towards oocyte	% Motility	Morphology of sperm cells	Number of sperm cells in the semen
0	0	0	0	0

- 7- Explain why there is no sperm in the semen (document 5) knowing that the semen is ejected.

**Question-31-**

Documents 1 and 2 represent the results of spermograms, of two owners of semen: one fertile (semen of Mr. X) and the other sterile (semen of Mr. Y).

Doc-1- Spermogram of Mr.X		
Mobility	After 1hr	After 4hr
% of normal mobility	55	45
% of decreased mobility	5	5
% of immobile forms	40	50

Vitality: 88% of living forms (1<sup>st</sup>hr) on 100 spermatozooids observed. It was noted : Typical Forms: 61% Atypical forms : 39%

Doc-2- Spermogram of Mr.Y		
Mobility	After 1hr	After 4hr
% of normal mobility	1	0
% of decreased mobility	6	0
% of immobile forms	93	100

Vitality: 0% of living forms (1<sup>st</sup>hr) on 100 spermatozooids observed. It was noted : Typical Forms : 60% Atypical forms : 40%

- 1- Compare the two spermograms. Conclude the possible causes of the sterility of Mr. Y.
- 2- Mr. X cannot have children with Madam X. Formulate two hypotheses about the possible causes of the sterility of this couple.

In order to verify the hypothesis, the following studies were done:

- We extract some proteins from zona pellucida of oocytes of fertile mice then we mark them by a radioactive isotope, and then we put them in the presence of spermatozoa of fertile mouse. It is found that the radioactivity appears at the level of the external side of the cell membrane of sperm-head.
- We place these marked sperms in the presence of mature oocytes. There is no fertilization.
- Spermatozoa which have not been put in contact with these previous proteins are still able to fertilize.

- 3- What do these observations reveal?

By Mr Rami Mawasi

**Question-32-**

Doc-1 shows the diagrams of three transverse & partial testicular microscopic sections of an individual before puberty and two pubescent individuals one of which is normal & the other sterile.

- 1-Annotate the figure of section B.

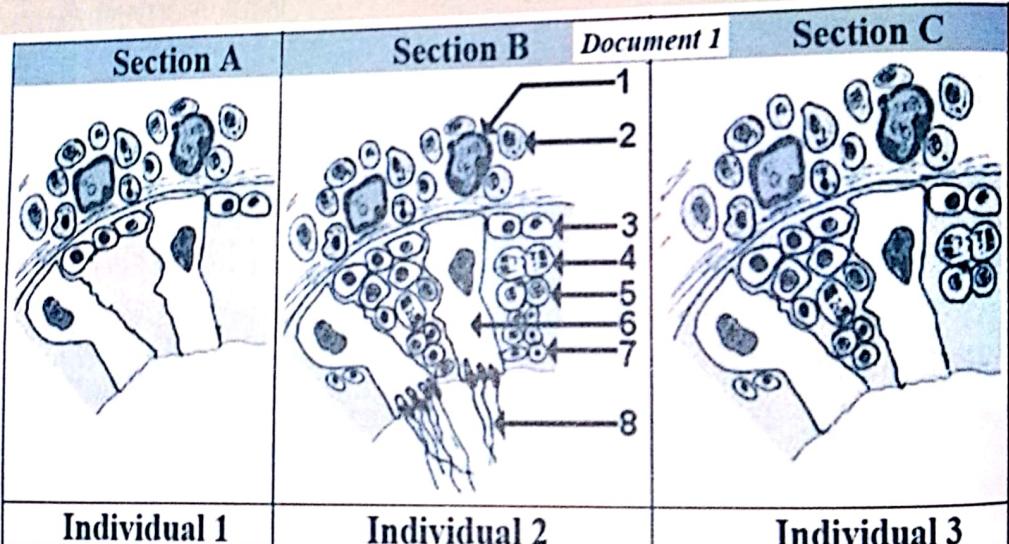
- 2- Compare the 3 sections.

- 3- Based on doc 1, specify which section belongs to the immature, sterile and the normal individuals.

- 4- Formulate a hypothesis explaining the possible cause of sterility of this individual.

To clarify the cause of infertility, the sterile individual was injected with daily doses of the hormones involved in the regulation of testicular function: H<sub>1</sub>, H<sub>2</sub>, H<sub>3</sub>, and H<sub>4</sub>. The results of injections are shown in the following table:

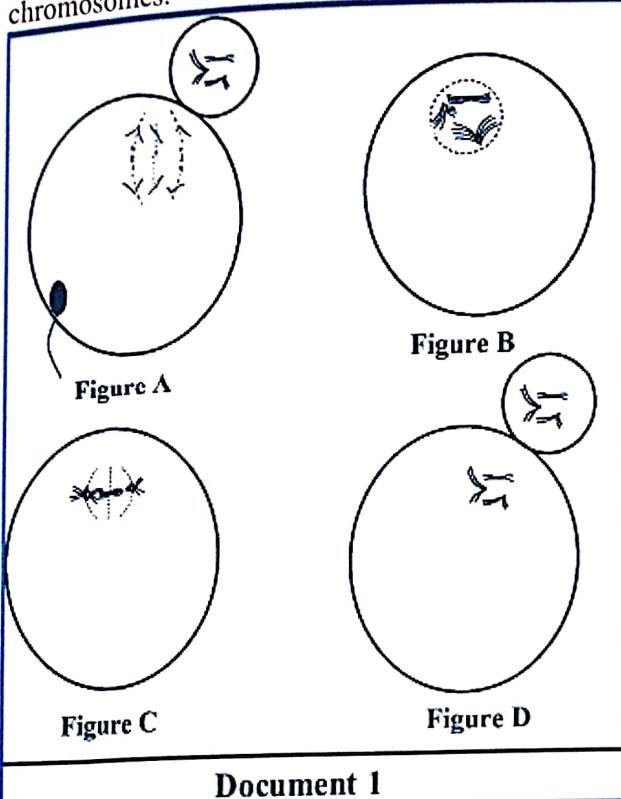
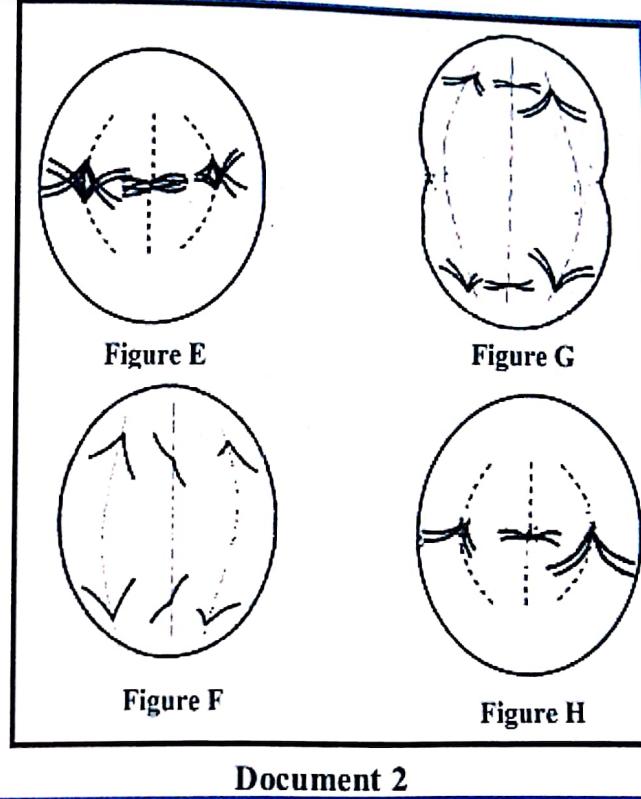
- 5- Using doc 2, determine the exact cause of sterility for this individual.



Doc-2-Hormone	Results
H <sub>1</sub> : Testosterone	Sperms produced
H <sub>2</sub> : LH	No effect
H <sub>3</sub> : FSH	No effect
H <sub>4</sub> : GnRH	No effect

**Exercise -33-****Gametogenesis**

The figures of documents 1 and 2 represent the germ cells in division at the level of a same step of gametogenesis in the man and woman. For the simplification of the phases, it was represented 3 pairs of chromosomes.

**Document 1****Document 2**

- 1- Identify, for each document 1 and 2, the type of gametogenesis.
- 2- Specify the step or phase of gametogenesis illustrated by the two documents.
- 3- Give the chronological order of the figures given in each document.
- 4- Complete the two tables.

<b>Doc-1- Figure</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Name of Germinal Cell				
Division Phase				
Number & state of chromosomes				
Place of Existence				

<b>Doc-2- Figure</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>
Name of Germinal Cell				
Division Phase				
Number & state of chromosomes				
Place of Existence				

Part 1 of 4 - Genetics  
Exercise -34-

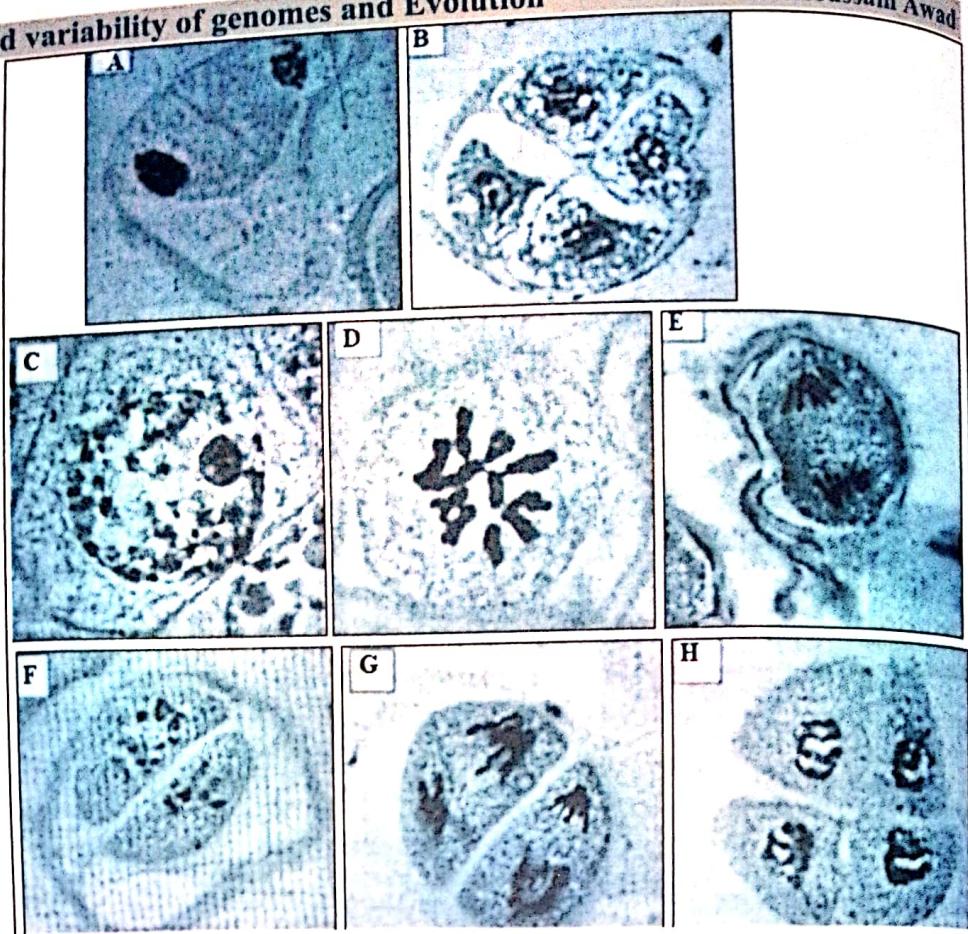
The vertebrates have a biological cycle where haploid phases and diploid alternate. It seeks to clarify what are the mechanisms that allow the species to maintain its equipment chromosome.

**Document 1:** photographs illustrating the behavior of chromosomes during the formation of the gametes.

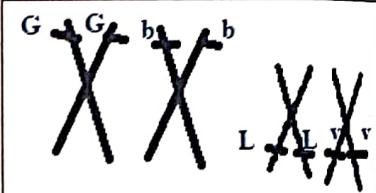
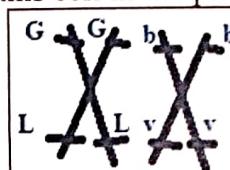
These photographs were taken in a plant for the clarity of the observation. The behavior of chromosomes is identical in vertebrates.

1- Specify the type of cell division revealed in document 1.

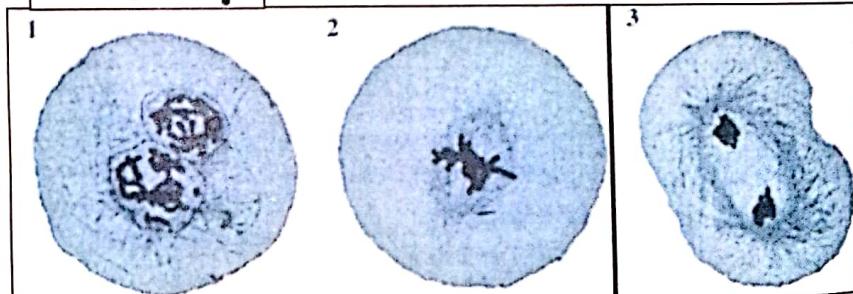
2- Arrange the labeled figures in chronological order.



3- Given the cell GbLv with  $2n=4$ . Draw this cell in the phases E & G. →



**Document 2:** Photographs of the phenomena that take place after the penetration of a male gamete in the female gamete in mice.



**Document 3:** Evolution in the amount of DNA in the nucleus of the male sexual cell, in the nucleus of the egg cell and in the nucleus of the embryonic cell, in function of time.

1: egg cell

2: embryonic cell

Segment IJ of the graph: replication of DNA in each kernel, prior to their merger

5- Indicate the phase in the graph for each diagram in document 2.

6- From the operating system and the development of the relationship of the documents 1 to 3, explain the mechanisms of the species to maintain its equipment chromosome.

