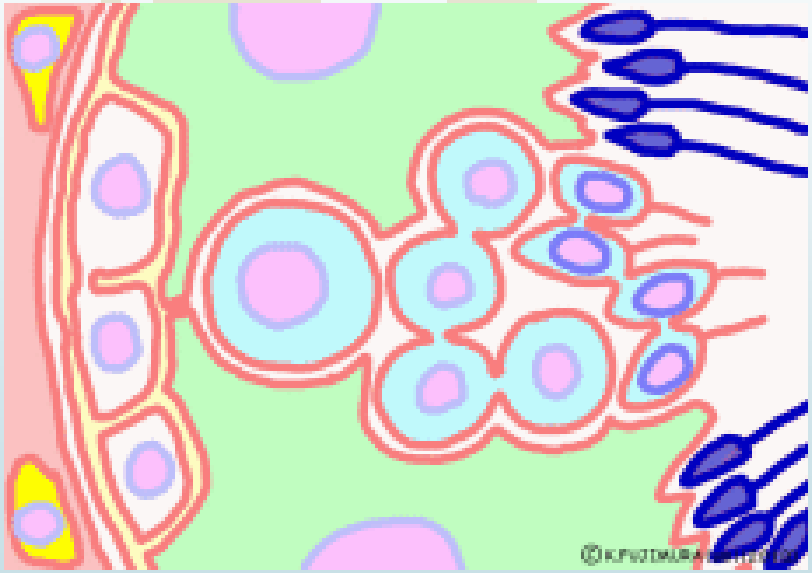
This chapter includes the following:

(Referring to the National textbook)

- Document 1: Male and Female Reproductive Systems
- Document 2: Diploid and Haploid Cells
- Document 3: Meiosis
- Document 4: Spermatogenesis
- Document 5: Oogenesis
- Document 6: Fertilization

Document 4:

Spermatogenesis



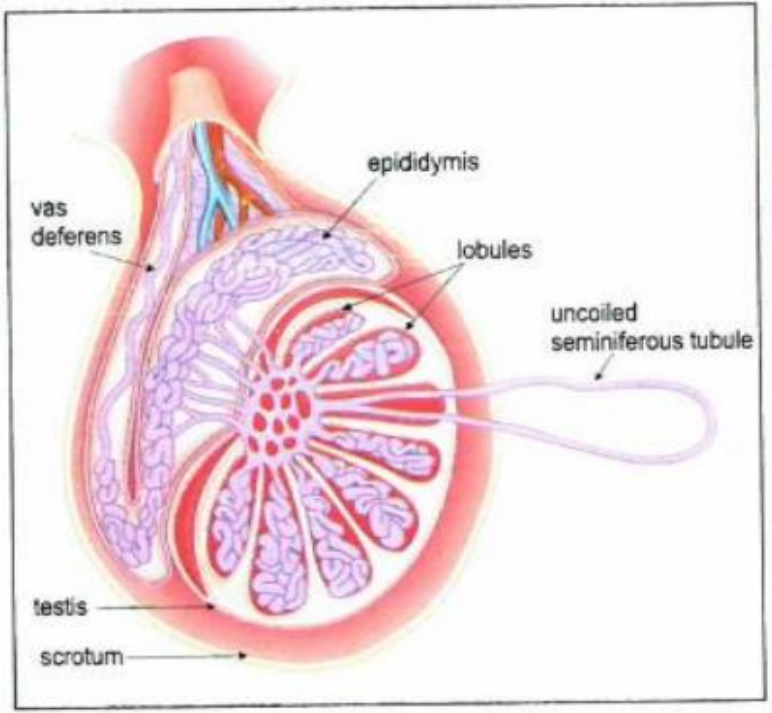
I. Histology of the Testes Doc. a, p.24

- A testis is composed of several coiled seminiferous tubules inside which spermatogenesis takes place.
- **Leydig cells:** are cells lying between seminiferous tubules.

☞ **Role:** They secrete a male hormone, the testosterone.

- **Sertoli cells:** are elongated irregular cells which extend inside the seminiferous tubules.

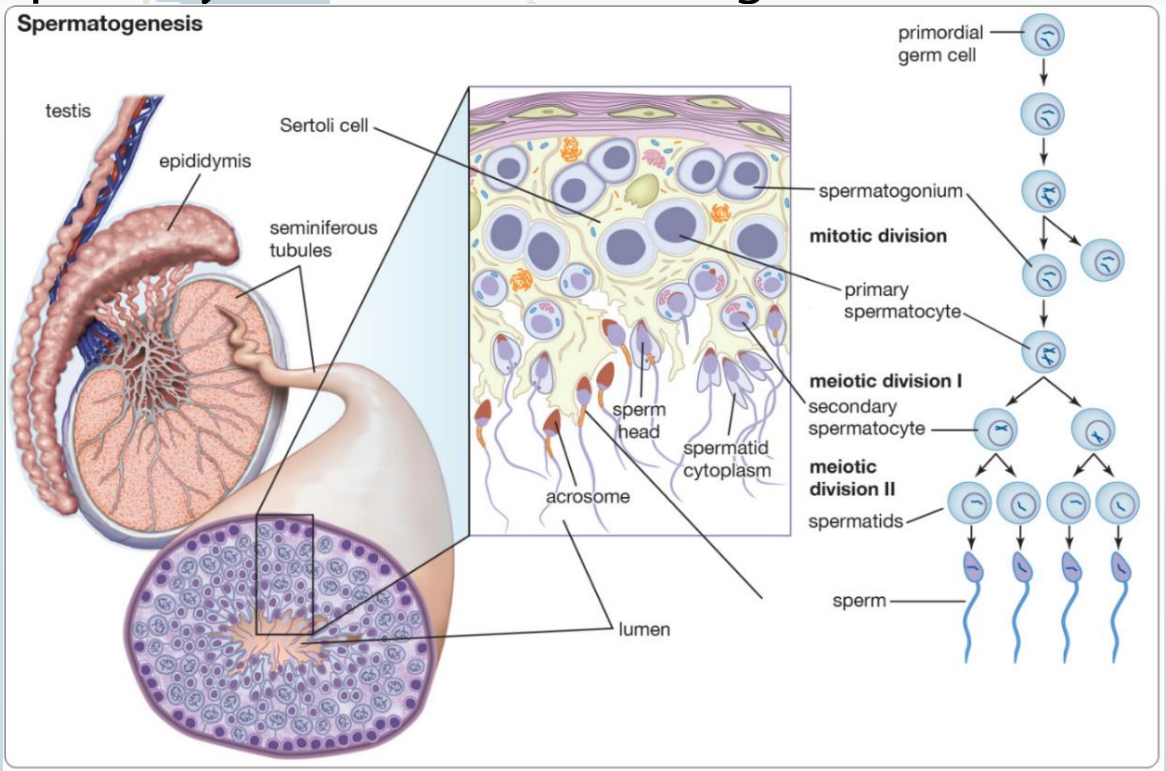
☞ **Role:** Provide nutrients to sperm cells.



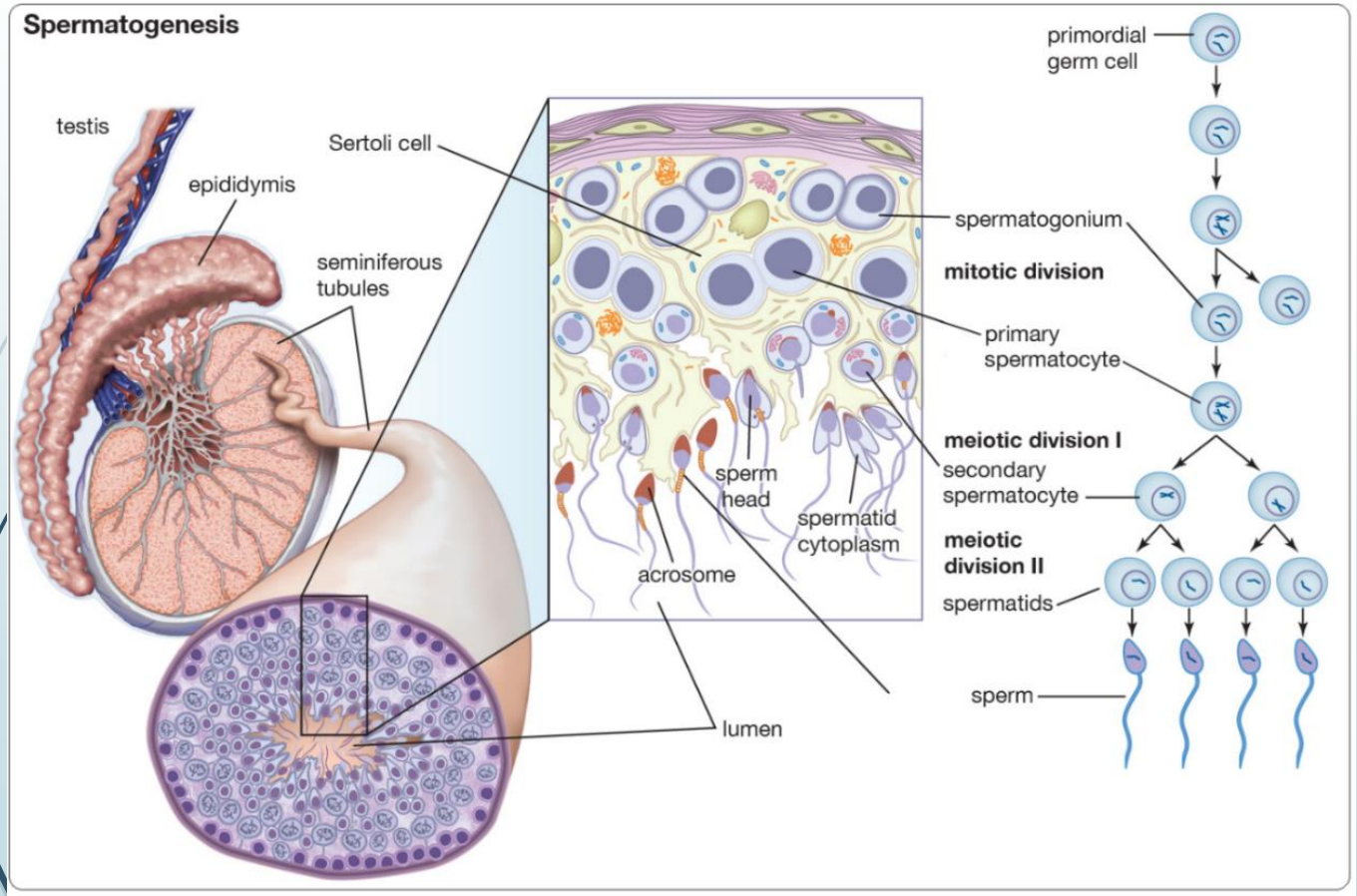
Doc.a *Longitudinal section of a testis and an epididymis.*

II. Spermatogenesis

- **Definition:** Is the process of production of haploid male gametes (sperms) starting from a diploid mother cell (spermatogonium) in the testes. It starts at puberty and continues throughout adult life.

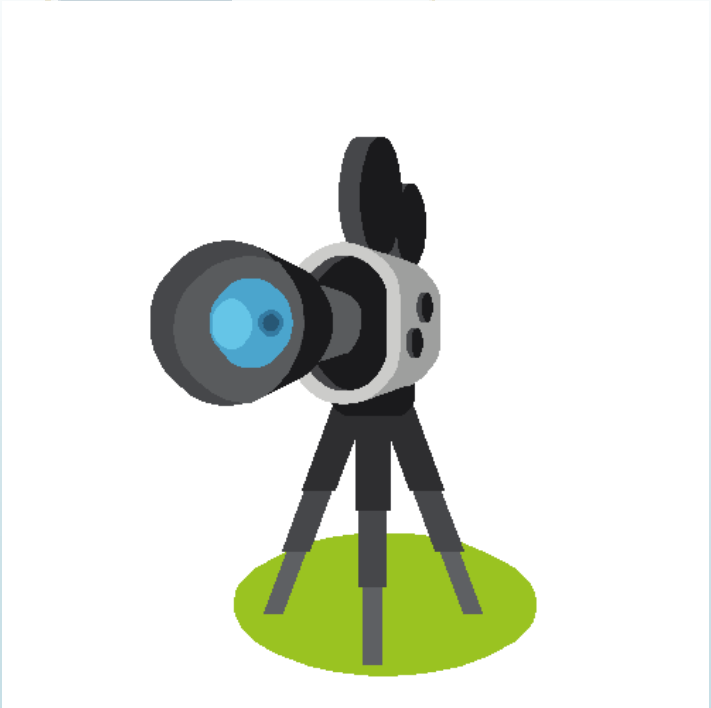


- **Location:** In testicles inside seminiferous tubules in a centripetal direction (from the periphery to the lumen of the tubule, towards the center).



- **Aim:** Production of sperms.
- **Duration:** In humans, each cycle needs around 74 days (2 months and a half).
- **Characterized** by production of millions of sperms (spermatozoa)

Video Time



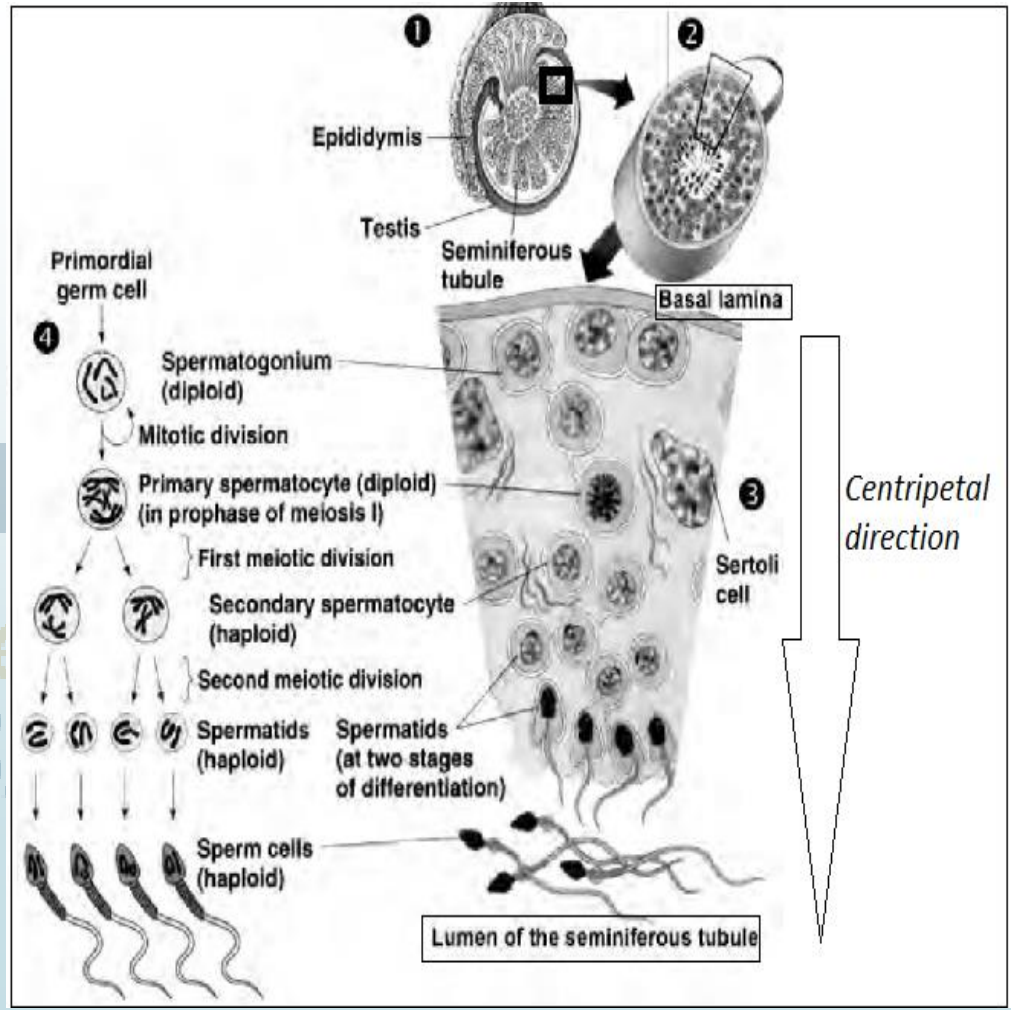
- **The adjacent document** (Doc. c p.24)**shows:**

❶: Longitudinal section of a testis.

❷: Cross section of a seminiferous tubule.

❸: interpretation diagram of a seminiferous tubule showing different stages of:

❹: Spermatogenesis



- **Doc.d p.25, shows stages of spermatogenesis which occur inside the seminiferous tubule (from basal lamina to lumen).**

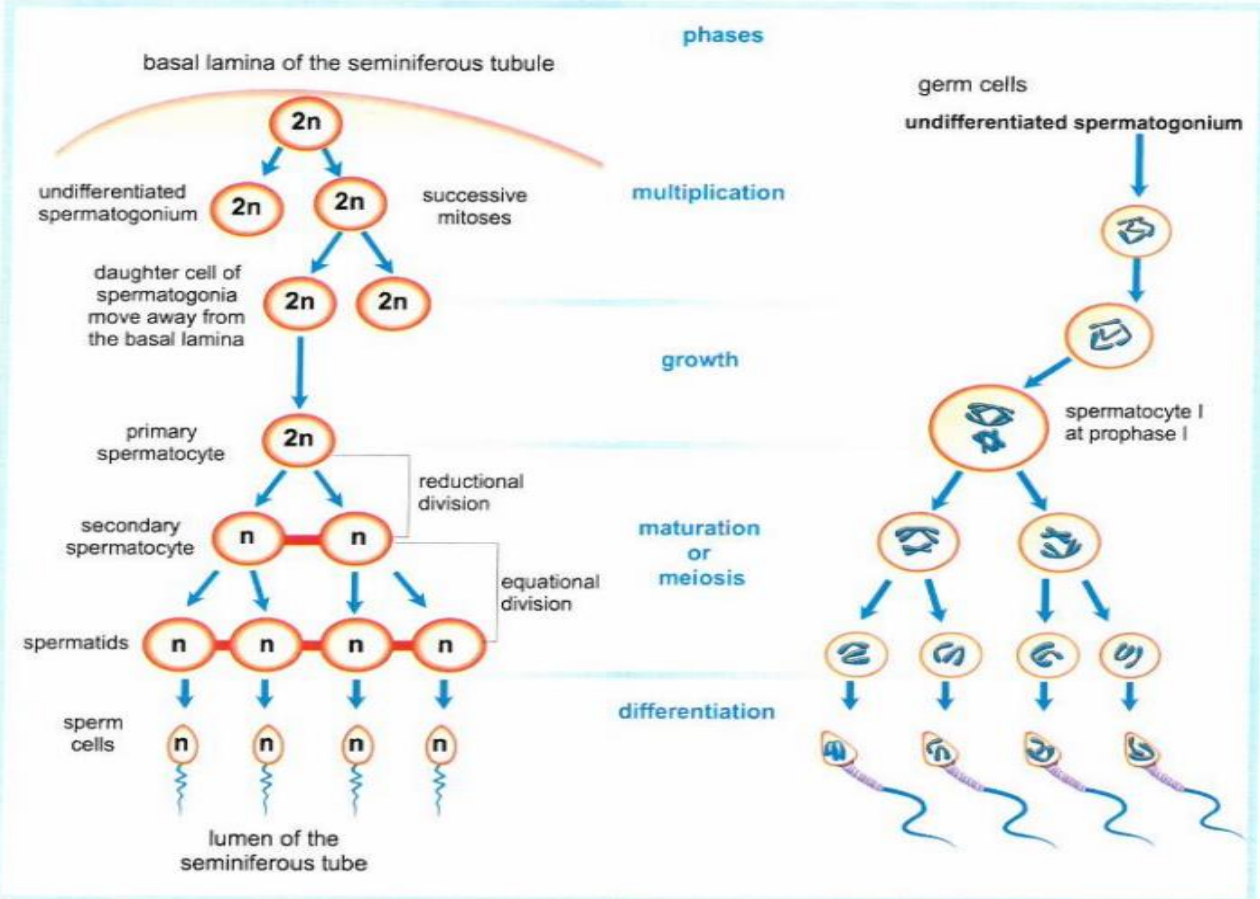
- Spermatogenesis includes 4 phases/ stages:

1- Multiplication:

- Characterized by successive mitosis, to produce many identical spermatogonium.

2- Growth:

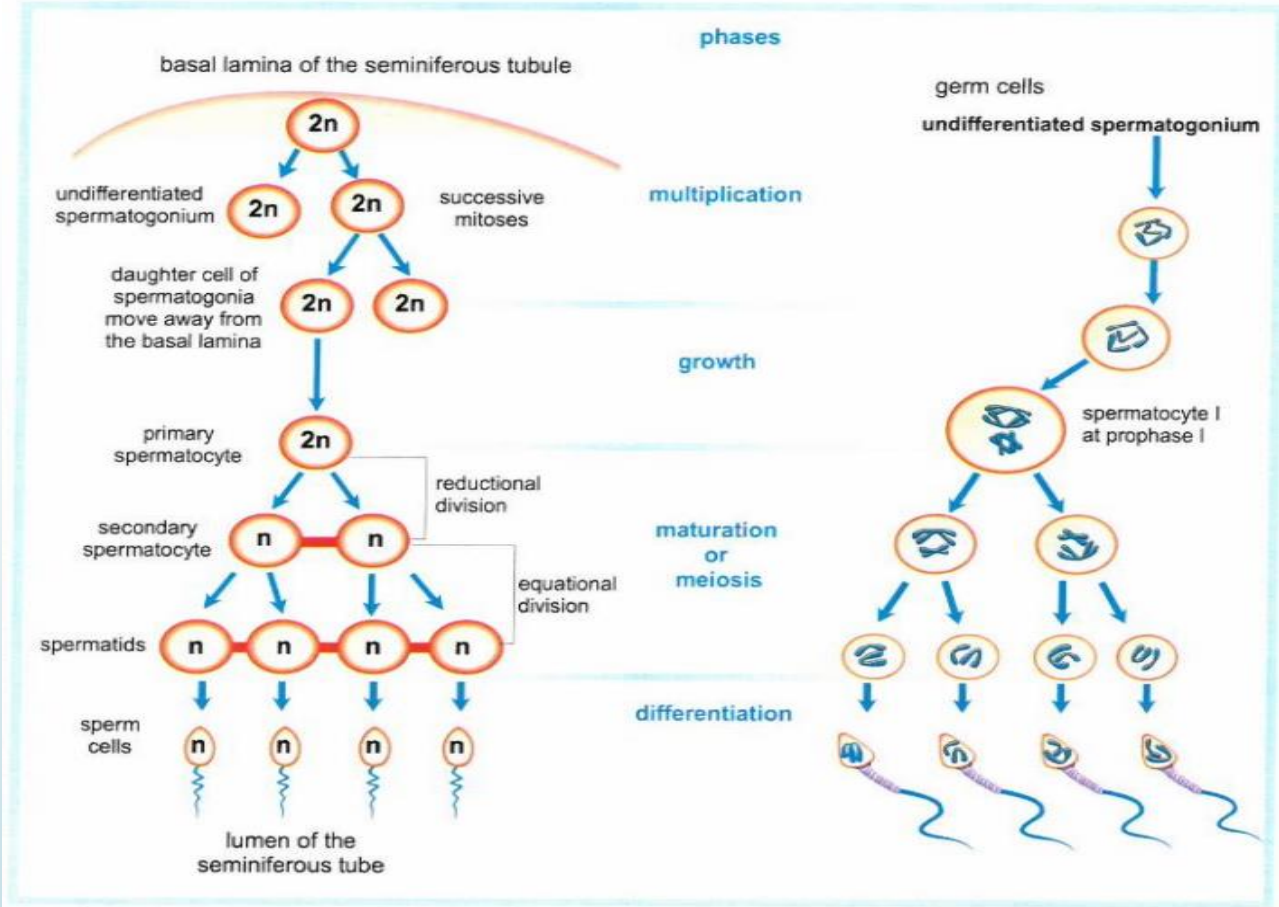
- Characterized by interphase, production of primary spermatocyte.



Doc.d *Stages of spermatogenesis and the corresponding chromosomal behaviour (to simplify, only 4 chromosomes have been drawn).*

3- Maturation:

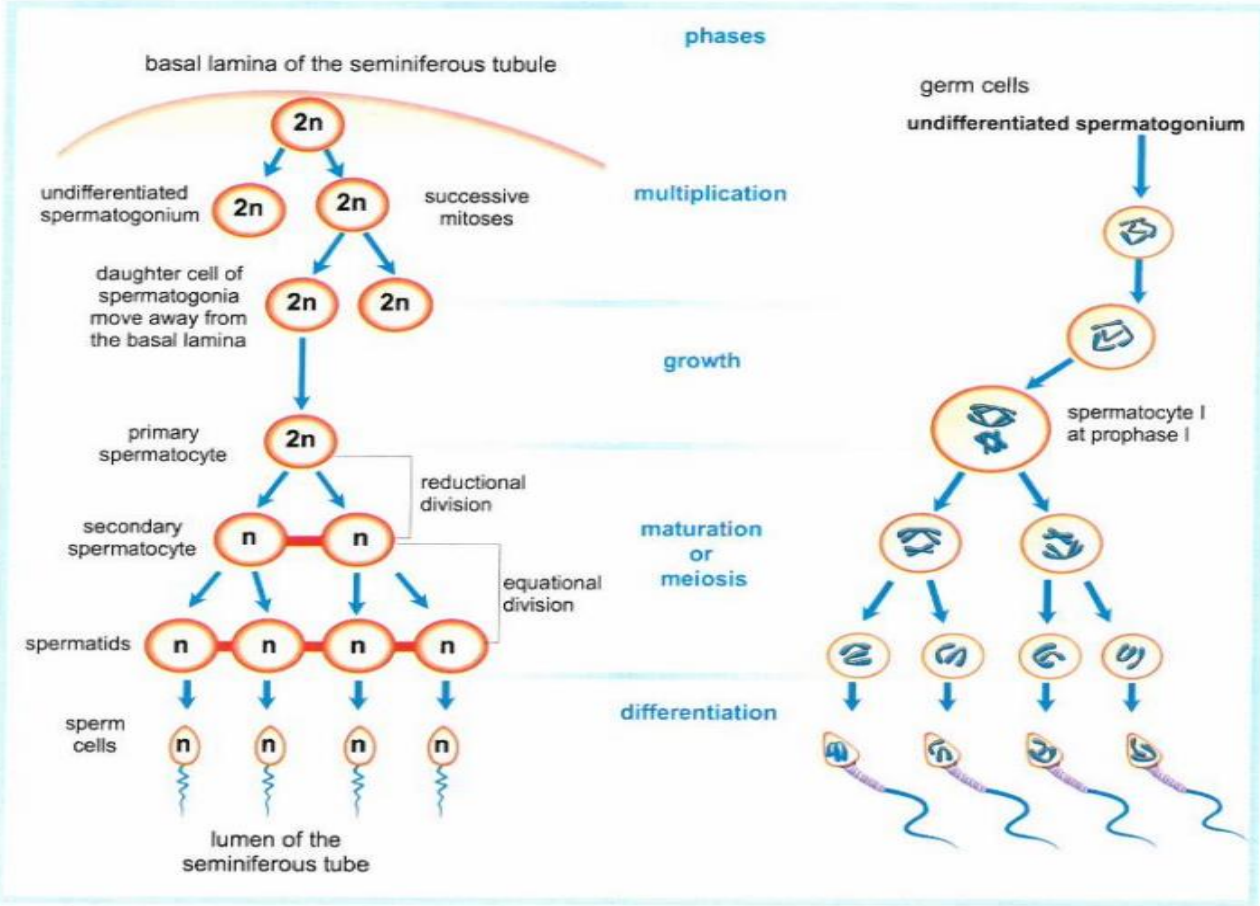
- Characterized by meiosis:
  - ☞ production of secondary spermatocyte after the meiois I (R.D).
  - ☞ production of spermatids after meiosis II (E.D).



Doc.d *Stages of spermatogenesis and the corresponding chromosomal behaviour (to simplify, only 4 chromosomes have been drawn).*

4- Differentiation:

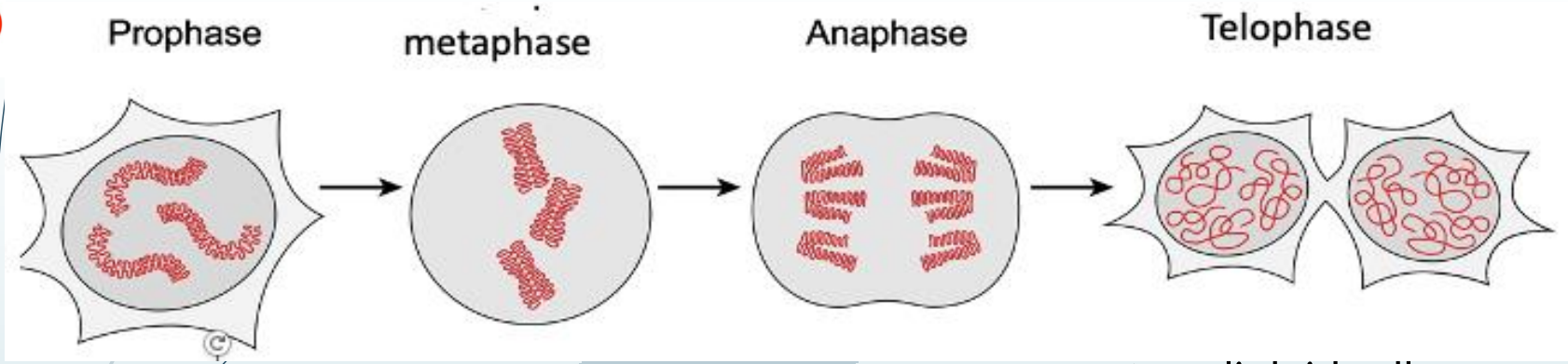
- Characterized by spermiogenesis during which spermatids are transformed into sperm cells, which are released from the Sertoli cells into the lumen of seminiferous tubule.



Doc.d *Stages of spermatogenesis and the corresponding chromosomal behaviour (to simplify, only 4 chromosomes have been drawn).*

Chromosomal Behavior During Multiplication:

Successive Mitosis



diploid cell containing chromosomes with two chromatids spermatogonia (2n = 46)

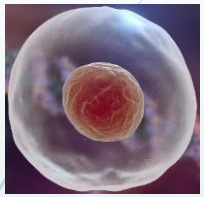
mitosis

two diploid cells containing chromosomes with one chromatid spermatogonia (2n = 46)

Mitosis does not change the number of chromosomes per cell.

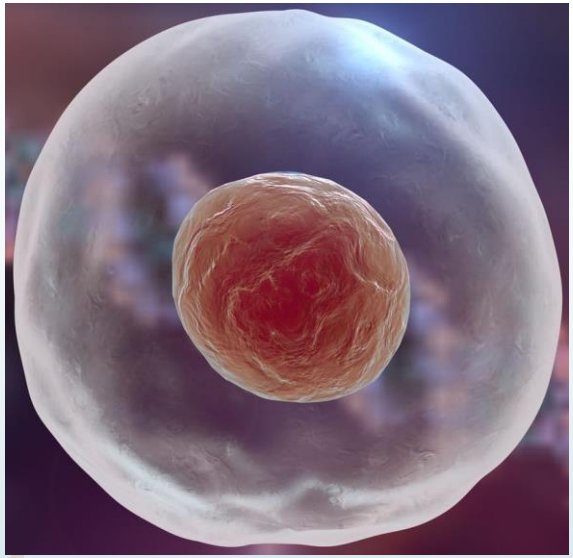
Document D'

Chromosomal Behavior During Growth:



Growth

interphase



spermatogonia: diploid cell containing chromosomes with one chromatid

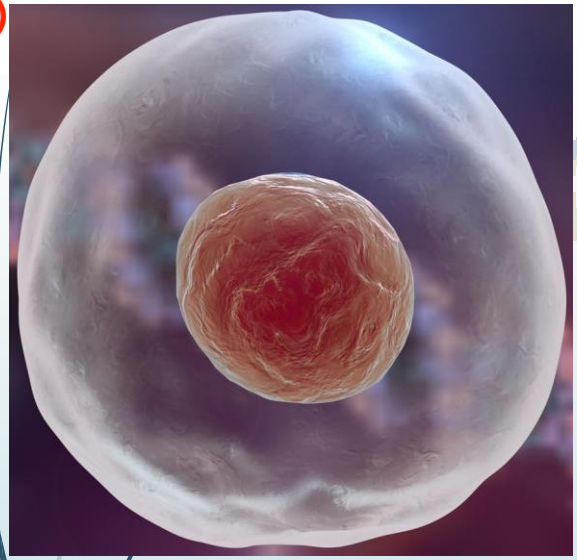
(2n = 46)

spermatocyte I: diploid cell containing chromosomes with two chromatids

(2n = 46)

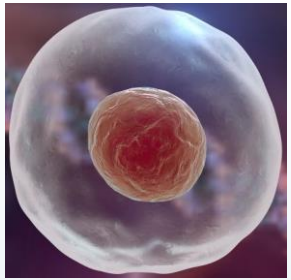
Document D'

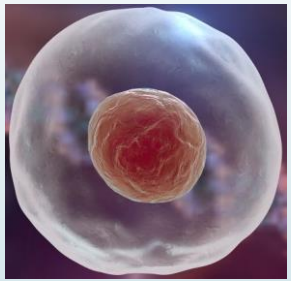
Chromosomal Behavior During Reductional Division of Meiosis:



reductional division

separation of chromosomes of each tetrad





spermatocyte I diploid containing chromosomes with two chromatids

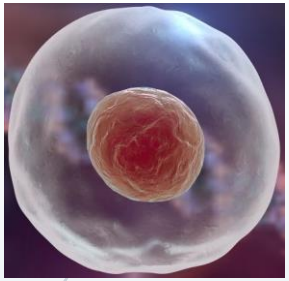
(2n = 46)

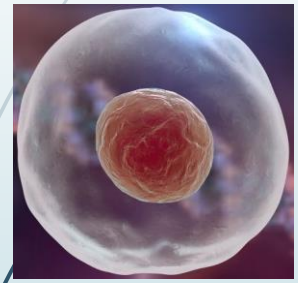
two haploid spermatocytes II containing chromosomes with two chromatids

(n = 23)

Document D'

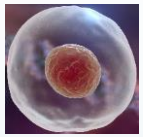
Chromosomal Behavior During Reductional Division of Meiosis:

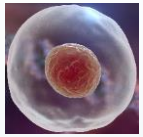


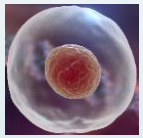


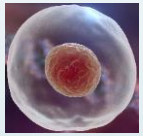
equational division

separation of chromatids of each chromosome







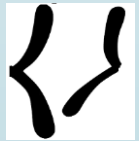


two haploid spermatocytes II containing chromosomes with two chromatids

(n = 23)

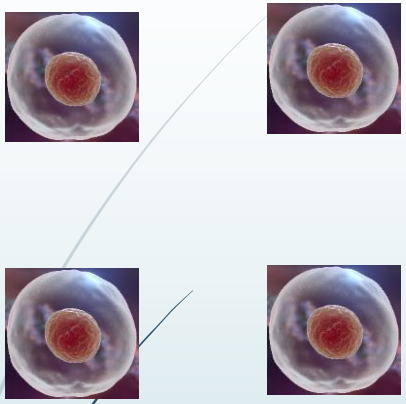
four haploid spermatids containing chromosomes with one chromatid

(n = 23)



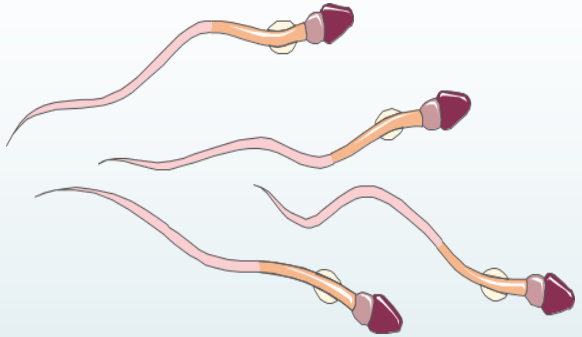
Document D'

Chromosomal Behavior During Differentiation:



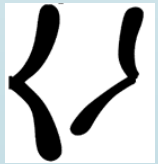
spermiogenesis

cytoplasmic transformations



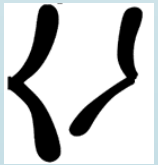
four haploid spermatids containing chromosomes with one chromatid

(n = 23)



four haploid spermatozoa containing chromosomes with one chromatid

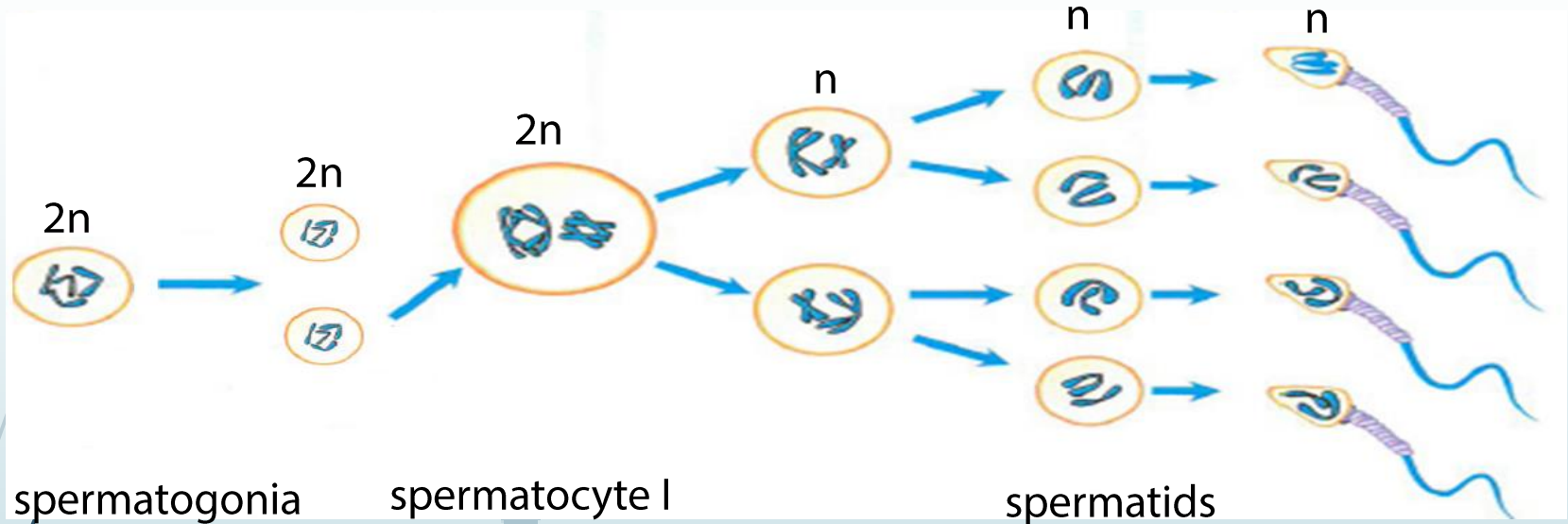
(n = 23)



Document D'

Chromosomal Behaviour During Spermatogenesis: Summary

multiplication growth maturation differentiation

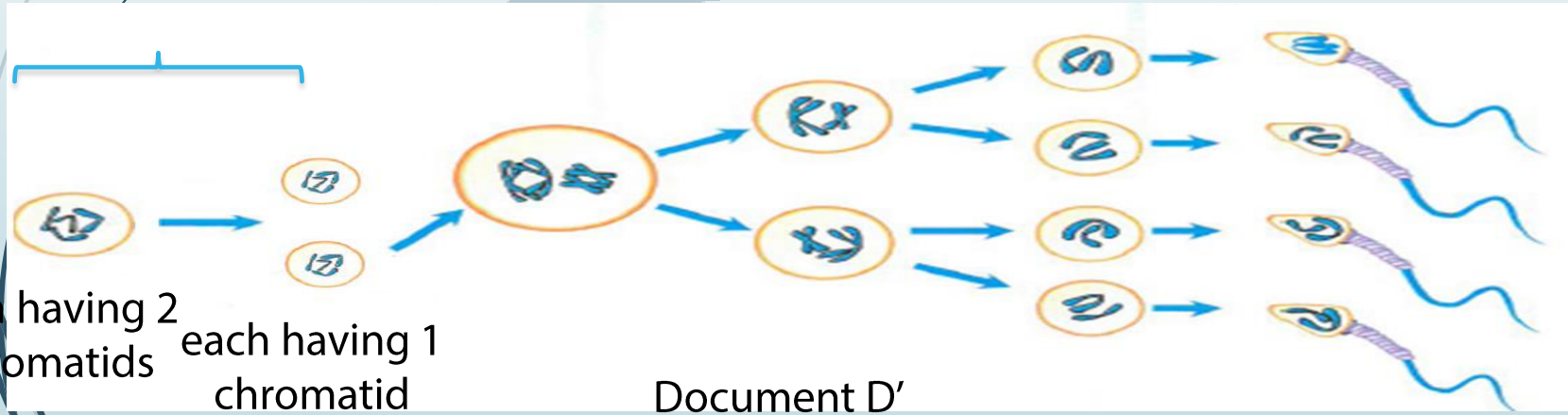


spermatogonia spermatocyte I spermatocytes II spermatids spermatozoa

Document D'

2- Indicate the Number of Chromosomes and Chromatids per Chromosome for Each Type of Cells During Spermatogenesis

spermatogonia	spermatocyte I	spermatocytes II	spermatids	spermatozoa
2n chromosomes	2n chromosomes each having 2 chromatids	n chromosomes each having 2 chromatids	n chromosomes each having 1 chromatid	n chromosomes each having 1 chromatid

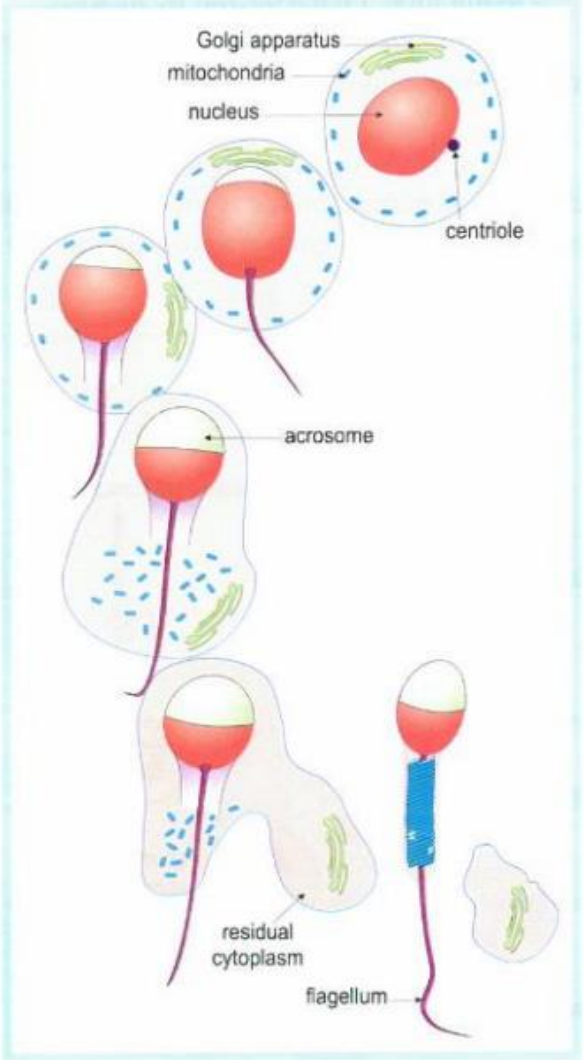


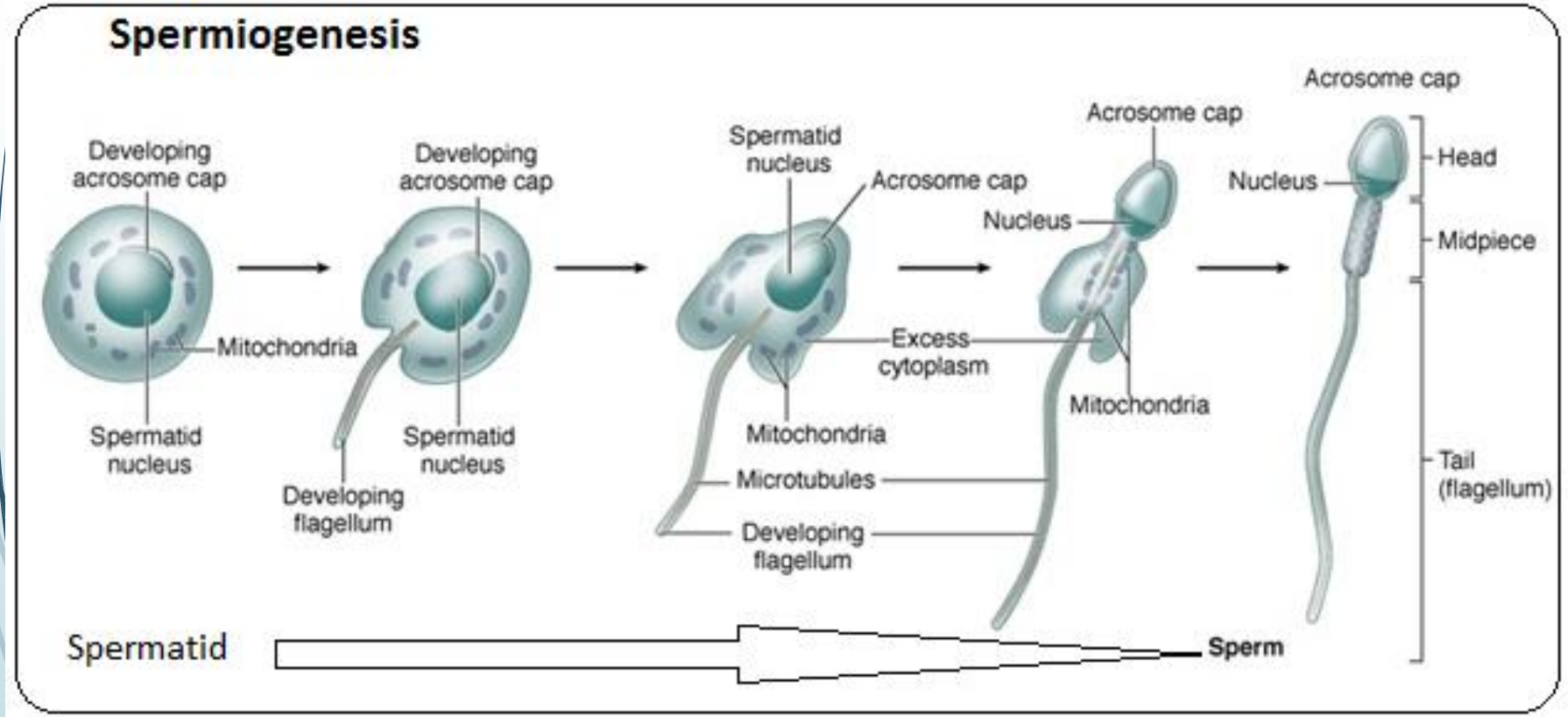
Document D'

- The steps or different stages of spermiogenesis are :

(Probing the Documents nb 4)

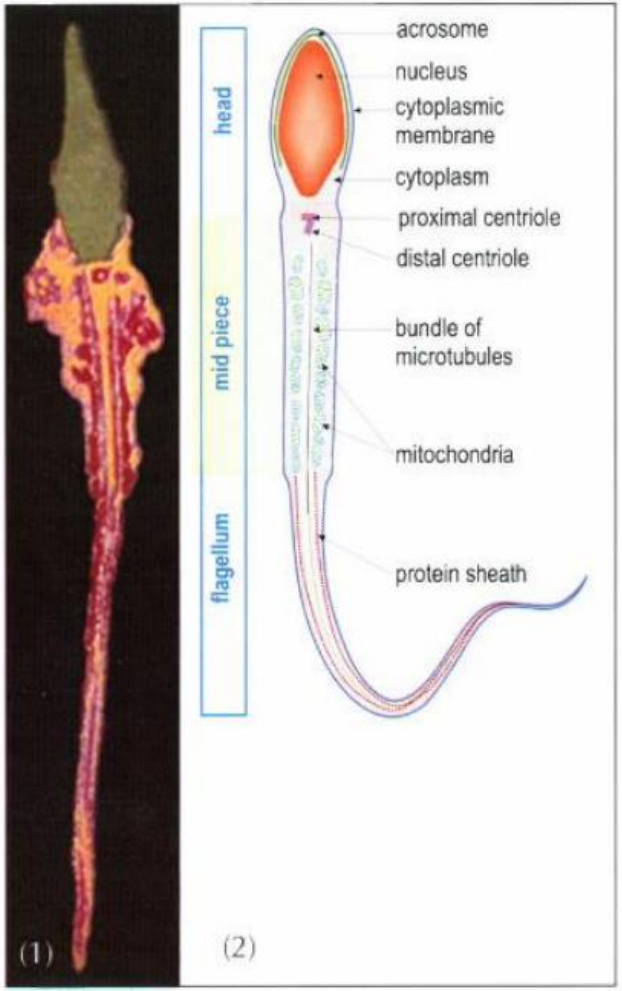
- Spermatid (round cell) changes into an elongated cell.
- The Golgi body forms the acrosome which is a structure found at the head of the sperm. Acrosome contains enzymes needed to digest the wall of an oocyte during fertilization.
- The mitochondria group together to form the mid piece. It provides energy needed for the mobility of the sperm's flagellum.




Spermiogenesis
Developing acrosome cap
Mitochondria
Spermatid nucleus
Developing acrosome cap
Spermatid nucleus
Developing flagellum
Spermatid nucleus
Acrosome cap
Excess cytoplasm
Mitochondria
Microtubules
Developing flagellum
Acrosome cap
Nucleus
Mitochondria
Acrosome cap
Nucleus
Head
Midpiece
Tail (flagellum)
Spermatid
Sperm

*A human sperm is composed of 3 parts: head, mid piece and flagellum. Doc. f p.26.

- The nucleus is located in the head region of the sperm where it occupies most of the cytoplasm and the remaining of the cytoplasm is transferred into a residual body which is eliminated and removed.



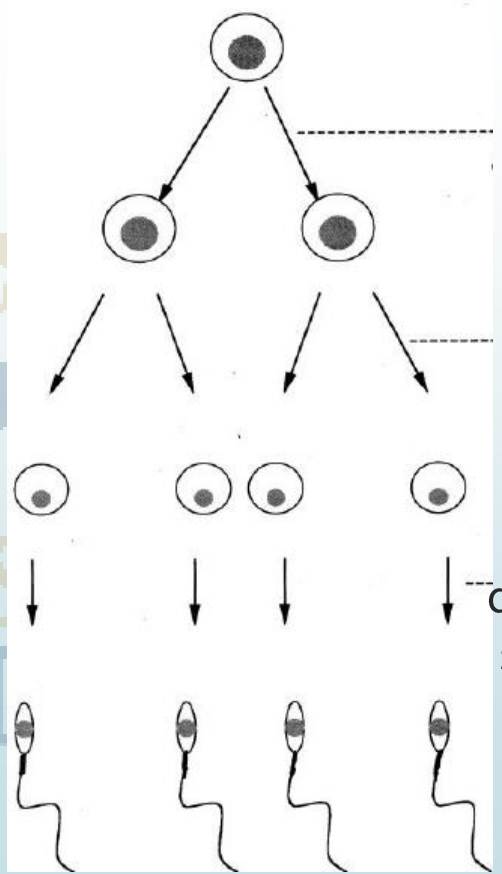
Doc.f *Photomicrograph (1) and labelled diagram (2) of a human spermatozoon.*

Official Exam Question

Exercise 1 (5 pts), Session 2 – 2009 / LS Series, Lebanese Baccalaureate

Two adult men, M.X and M.Y., are sterile. In order to determine the origin of this condition, various tests are performed.
Document 1 shows certain stages of spermatogenesis;
Germ cells are present in the wall of the seminiferous tubules of the testes.

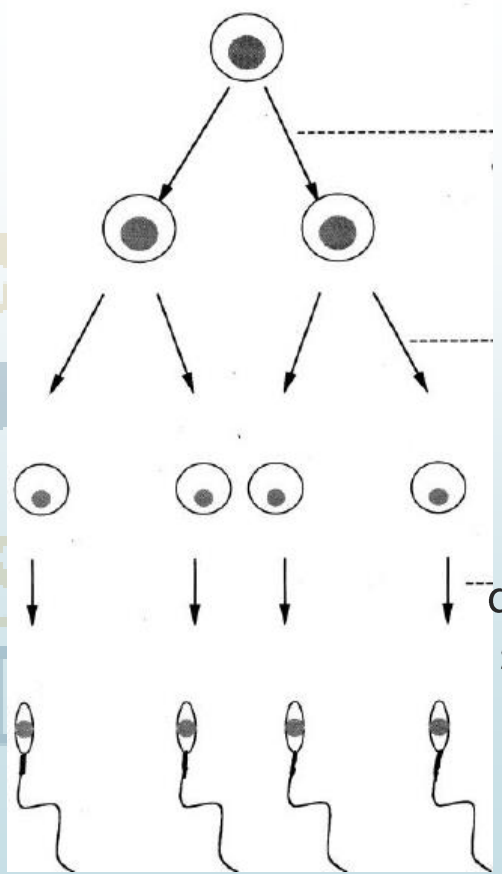
1- **Describe the different stages of spermatogenesis represented in document 1.**



Document 1

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

During reductional division, spermatocyte I divides into two spermatocytes II which undergo equational division, each gives two spermatids. Then, each spermatid differentiates into spermatozoon by spermiogenesis (1/2 pt).



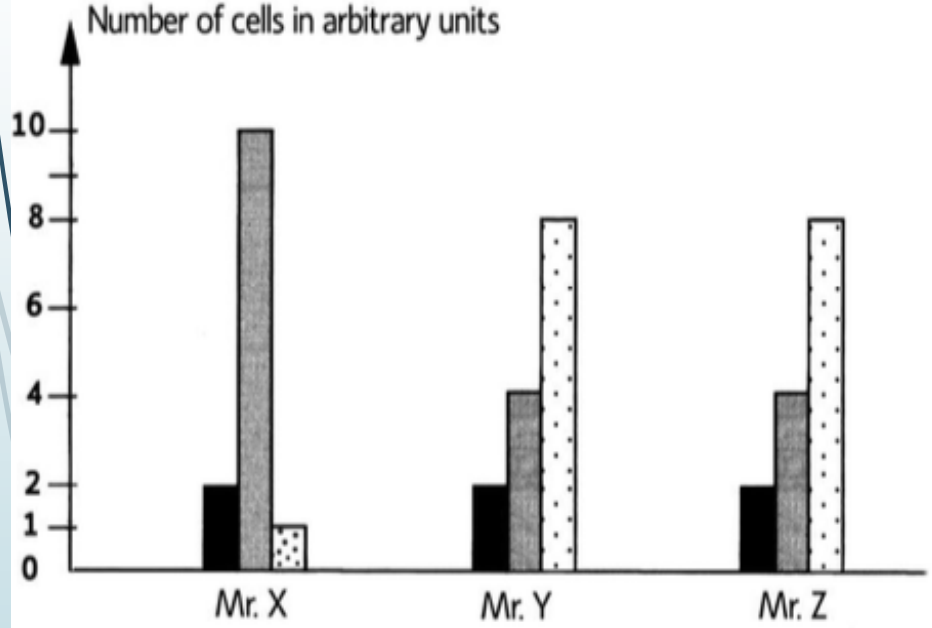
Document 1

Exercise 1 (5 pts), Session 2 – 2009 / LS Series, Lebanese Baccalaureate

A quantitative study of the DNA level of germ cells extracted directly, by biopsy, from a fragment of the testicles of these two sterile men and a fertile man M.Z. Three different populations of germ cells are obtained. The number of each cell population, as well as the amount of DNA in each of them are shown in document 2.

Exercise 1 (5 pts), Session 2 – 2009 / LS Series, Lebanese Baccalaureate

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



Population 1; [DNA] = 2Q (arbitrary units)

Population 2 ; [DNA] = Q

Population 3; [DNA] = Q/2

Document 2

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

Population 1 corresponds to spermatocytes I
because the quantity Q is duplicated during the S phase of the interphase and becomes 2Q in spermatocyte I that has 2n chromosomes of two chromatids each. (1/2 pt)

Population 2 corresponds to spermatocytes II
because after the reductional division of meiosis we obtain spermatocytes II that has n chromosomes with two chromatids each and corresponding to the quantity Q of DNA. (1/2 pt).

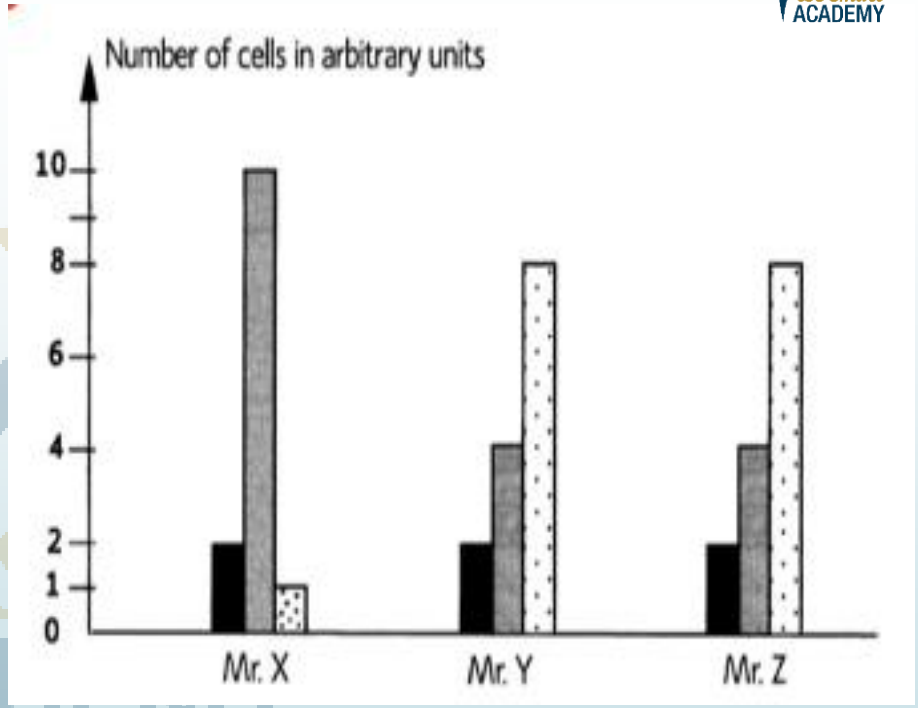
Population 3 corresponds to spermatids or spermatozoa
because after the equational division we obtain 4 cells (spermatids) having n chromosomes with one chromatid each, which corresponds to the quantity Q/2 of DNA. This same quantity remains constant after spermiogenesis that gives sperm cells (spermatozoa). (1/2 pt)

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

In fertile men, the number of germ cells is doubled from 2 to 4 and then to 8, passing from population 1 to population 3.

This corresponds to the course of meiosis where the number of cells doubles after each meiotic division.

Spermatocyte I gives 2 spermatocytes II and each of them gives 2 spermatids (1-2-4). (1/2 pt)



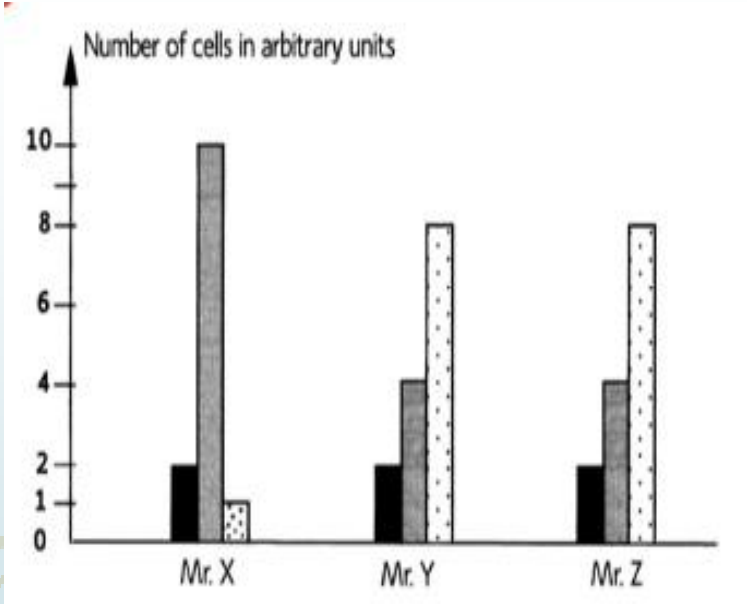
Document 2

4- Determine, based on document 2, the cause of Mr. X's infertility.

In the sterile man X, the number of spermatocytes I is identical to that observed in the fertile man (2 a.u), but the number of spermatocytes II is greater in the sterile man 10 a.u than in the fertile man 4 a.u. On the other hand, the number of spermatids or sperm cells is abnormally lower in this sterile man 1 a.u than in the fertile man 8 a.u.

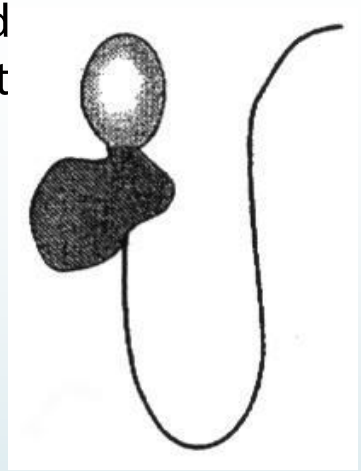
This indicates that not all spermatocytes II had divided into spermatids during meiosis.

Therefore, the cause of sterility in man X is the abnormal meiosis which is blocked at the stage of spermatocyte II, and which causes an insufficient number of sperm cells or oligospermia. (1 pt)



Document 2

Microscopic observations made on the semen of Mr. Y showed sperm cells; most of which have an appearance identical to that schematized in document 3.



Document 3

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

Document 2 reveals that in the sterile man Y the number of cells of the three populations is the same as in the fertile man Z;
This indicates that meiosis is taking place normally in man Y, hence a normal number of spermatids and sperm cells; therefore, he does not have oligospermia (1/2 pt).
In contrast, Document 3 shows one type of sperm cells with a normal flagellum and head, but the mid piece is larger than in normal sperm cells. This is due to the non-elimination of the residual cytoplasm causing the sterility of Mr. Y.(1/2 pt)
Hence, the origin of the sterility of man Y is the abnormal spermiogenesis. (1/2 pt)