Developmental biology ana Reproductive endocrinology

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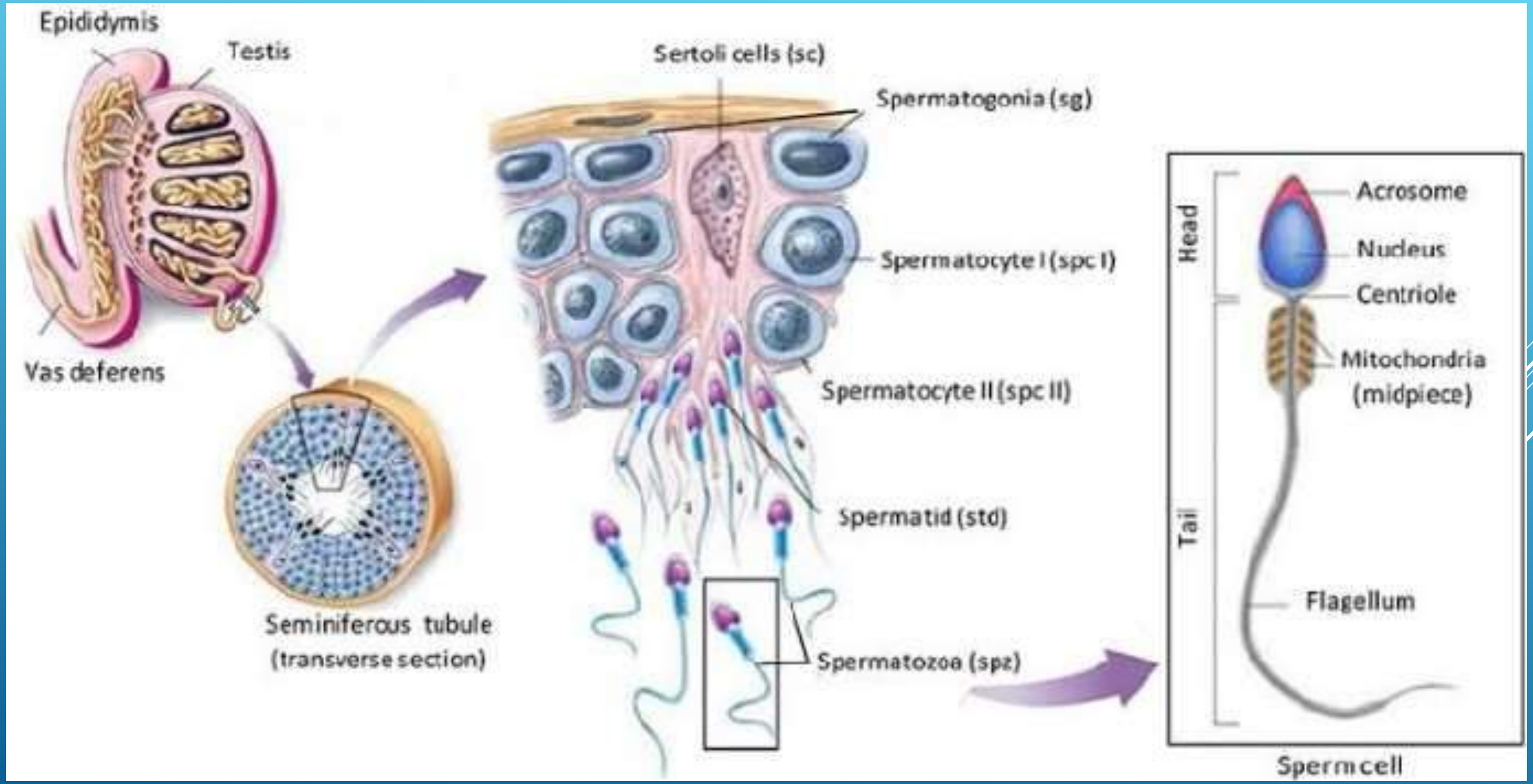
CLASS-3RD SEMESTER

UNIT 2- EARLY EMBRYONIC DEVELOPMENT

Gametogenesis

•DEFINITION: Human gametogenesis is the process by which diploid germ cells (Spermatogonia or Oogonia)form haploid cells (Spermatozoa or Ova) through sequences of cell divisions and cell differentiation. It can simply be described as a procedure by which sperms and ova are designed in the testes and ovaries respectively. In the male, the process is known as Spermatogenesis and produces spermatozoa, while in the female it is refer to as Oogenesis and results in the formation of ova (Eggs)


Epididymis
Testis
Vas deferens
Seminiferous tubule
(transverse section)
Sertoli cells (sc)
Spermatogonia (sg)
Spermatocyte I (spc I)
Spermatocyte II (spc II)
Spermatid (std)
Spermatozoa (spz)
Head
Tail
Acrosome
Nucleus
Centriole
Mitochondria
(midpiece)
Flagellum
Sperm cell

SPERMATOGENESIS

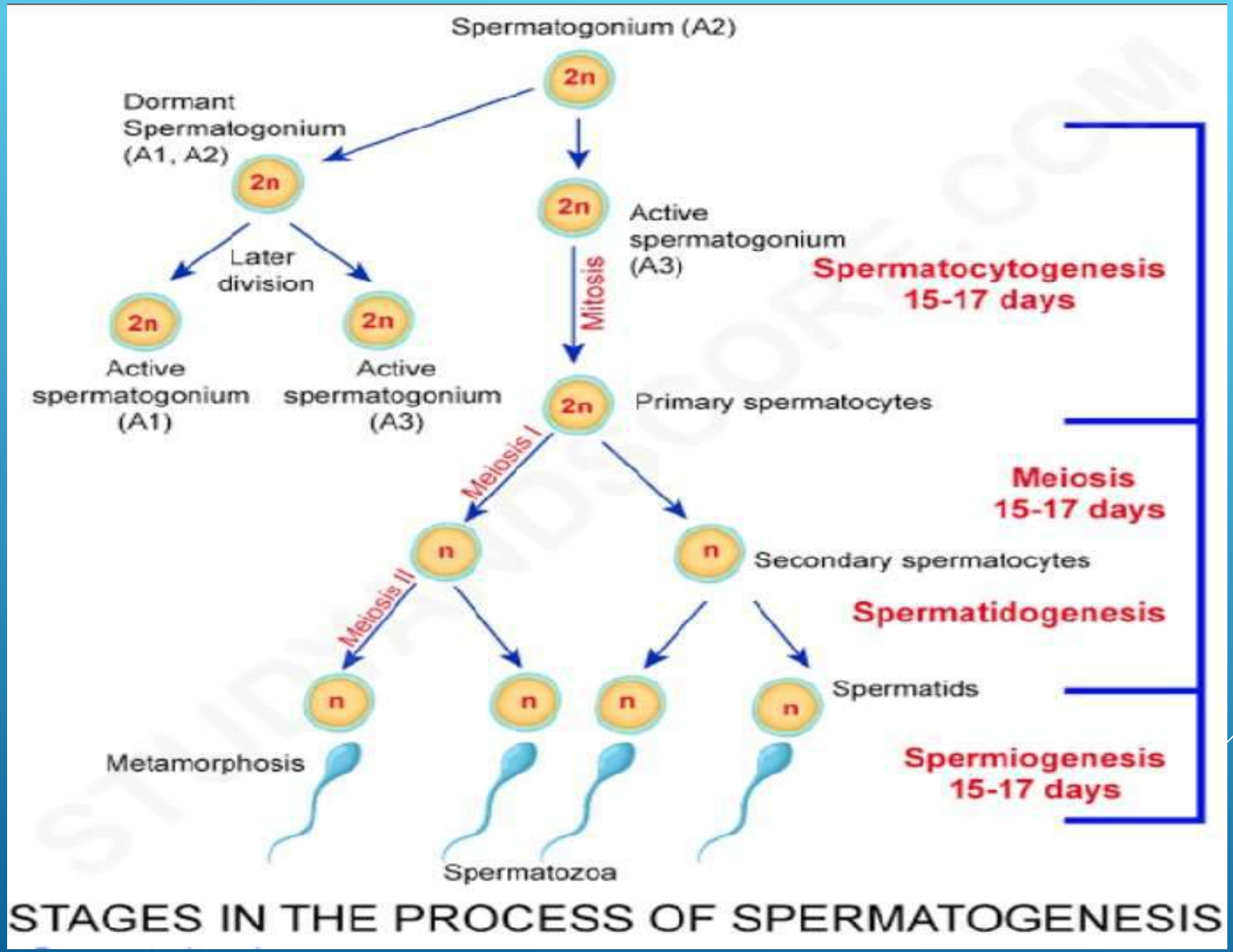
••••Spermatogenesis is the process by which spermatogonia are transformed into mature spermatozoa

Spermatogenesis takes place in the seminiferous tubules. The germinal tubules are lined with germinal epithelium which largely comprises of primordial germ cells and supporting cells (Sertoli cells)

Males start producing sperms when they attain puberty.

Sperms are produced in large quantity (100 to 200 millionper day) to maximise the possibility of sperm reachingthe liberated egg

Sperms are produced continually, because males need to utilize the small fertility window of the female



STAGES IN THE PROCESS OF SPERMATOGENESIS

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Spermatogenesis has three sequential phases:

Mitotic proliferation phase

Meiotic division phase

Cytodifferentiation phase

Mitotic proliferation phase:

is a phase that produces large number of cells through mitotic divisions.

Just before puberty, the sex cords of the testes acquire lumen and becomes seminiferous tubules and concurrently, primordial germ cells give rise to spermatogonial stem cells (SSCs) which form a pool

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At successive interval, the SSC pool releases some cells to form Spermatogonia Type A and their production marks the beginning of spermatogenesis

Each of these type A spermatogonia undergoes a number of mitotic divisions to produce a clone of 16 cells

Each of the cells in the clone undergoes a further several mitotic divisions to form type B spermatogonia

The number of mitotic divisions from SSC to type B spermatogonia determines the total number of cells in the clone.

Their number is however reduced by apoptosis to a large extent

Each of these Type B spermatogonia then undergoes further mitotic divisions to form

Resting Primary spermatocyte whichmarks the end of proliferation phase

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It is to be noted that all through the mitotic phase of spermatogenesis, nuclear division (Karyokinesis) is complete, but cytoplasmic division (Cytokinesis) is incomplete.

Hence theprimary spermatocyte derived from one type A spermatogonium are linked together by thin cytoplasmic bridges

This linkage persist even in the meiosis phase and continue till the formation of mature spermatozoa

Meiotic division phase

••••The meiotic division phase is aimed at reducing the chromosome number to half and to create genetic diversity

Prior to entering the prophase 1 of first meiosis, each resting primary spermatocyte duplicates its DNA content

These primary spermatocytes with the duplicated DNA then enter the prophase 1 of first meiosis which is very prolonged and lasted for about 22 days as it passes through its different stages (leptotene, zygotene, pachytene, diplotene and diakinesis)

During the pachytene stage of prophase 1, the sister chromatidstrands on the paired homologous chromosomes come together to form synaptonemal contacts during which the chromatids break, exchanged segments of genetic materials and then rejoin, there by shuffling the genetic information before separating themselves

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The first meiotic division ends with the separation of homologous chromosomes to the opposite pole of the cell on the meiotic spindle, followed by cytokinesis whichresults in the formation of two secondary spermatocytes

The secondary spermatocytes contain a single set of chromosomes consisting of two chromatids joined at the centromere.

The secondary spermatocytes are short-lived as theyquickly enter into the second meiosis during, which the chromatids separate and move to opposite pole of the second meiotic spindle

This is followed by formation of nuclear membrane and cytokinesis yielding haploid round spermatids

CYTODIFFERENTIATION PHASE

••The Cytodifferentiation phase involves the remodelling or transformation of the round spermatids into mature spermatozoa and is refer to as spermiogenesis

During this process, some major cytoplasmic changes occur. Such changes include the followings:

The spermatids change shape from round to elongated

Tail for forward propulsion is formed

Mid-piece containing mitochondria is formed.

The mitochondria generate energy for the cell.

Condensation of the nucleus takes place

Formation of Acrosome that occupy about half of the head of the sperm from the Golgi apparatus.

The acrosome contains enzyme that aid penetration of the ova and its surrounding layers during fertilization

Shedding of most of the cytoplasm

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The end result of spermiogenesis is the formation of mature spermatozoa

With appearance of the spermatozoa, the thincytoplasmic bridges rupture and the sperm cells are released into the lumen of the tubules in a process called spermiation and are washed along the tubules with the testicular fluid secreted by the Sertoli cells

From the seminiferous tubules, the spermatozoa enter the epididymis during which they become fully motile

Spermatogenic cycle

••••There are about 30 seminiferous tubules per testis inhuman.

In each of them certain number of spermatogoniae merge from the SSC pool to commence spermatogenesis

Once spermatogenesis commences in a tubule from SSCpool, new spermatogonia cannot emerge to generate a new clone until several days elapsed

The period of occurrence of successive spermatogenesis is said to be constant and species specific.

It is 16 days for human and 12 days for rat

This cyclical initiation of spermatogenesis is what is refer toas spermatogenic cycle

Thank you everyone.... For better knowledge read your books