B.SC - Semester 2

(Core course – Theory)

Course Code – 1ZOOTC0201

Course Title - Comparative anatomy and developmental biology of vertebrates

UNIT: 5

Topic :Gametogenesis

Gametogenesis is the first step of embryogenesis.It began when organisms becomes sexually mature. In most of animals it takes place only during breeding seasons but in Certain mammals like man it is continuous process until male and female sexually inert .

Definition: Gamogenesis is the process of formation and differentiation of haploid gametes (sperm and ova) from the diploid primary germ cells called gemetogonia means spermatogonia and oogonia present in primary sex organ called gonades ie. testis in male and ovaries in female. Primary germs cell in both testes and ovary are extra gonidal in origin because these are developed from extra embryonic mesoderm but finally migrate in to the gonads of developing embryo for further development.

Types of gametogenesis

1) spermatogenesis

2) oogenesis

a) Spermatogenesis: it is the formation of haploid and functional male gametes called spermatozoa from the diploid reproductive cells that is spermatogonia which is present in the testis of male organism. It occurs only after attaining of puberty and is maintained with advancing age. The rate of spermatogenesis decline in old age due to decline in testosterone secretion. but there is no clear cut male menopause.

Period. In the seasonally breeding animals e.g bat, ottter etc. the testes undergo testicular cycle in which the testes and their spermatogenetic

tissue become functional only in the specific breeding season. In this season testes enlarge, become functional and descend into the scrotum but become reduce, non-functional and ascend into the abdomen in other season. But in human male,lion,bull,horse etc. the testes lies permanently in the scrotum and spermatogenesis occurs through out the years but in elephants, whales and seal's, testes are permanently abdominal in position

Spermatogenesis is a continuous process and is complete in about 2 month and 14 days. (74) Days

Mechanism

Spermatogenesis is divided in to two part

1. Formation of spermatid

a) Multiplicative phase

b) Growth phase

C) Maturation or meiotic phase

2. Differentiation of spermatozoa

a) Formation of head

b) Formation of neck

c) Formation of middle piece

d) Formation of manchette

e) Formation of tail

A) Multiplicative phase: In this phase rapid mitotic division occur in diploid primary germs cell called gonocytes present in germinal epithelium of the somniferous tubules of the testes. This form large number

of diploid and rounded sperm mother cells called spermatogonia.
Fig. given below

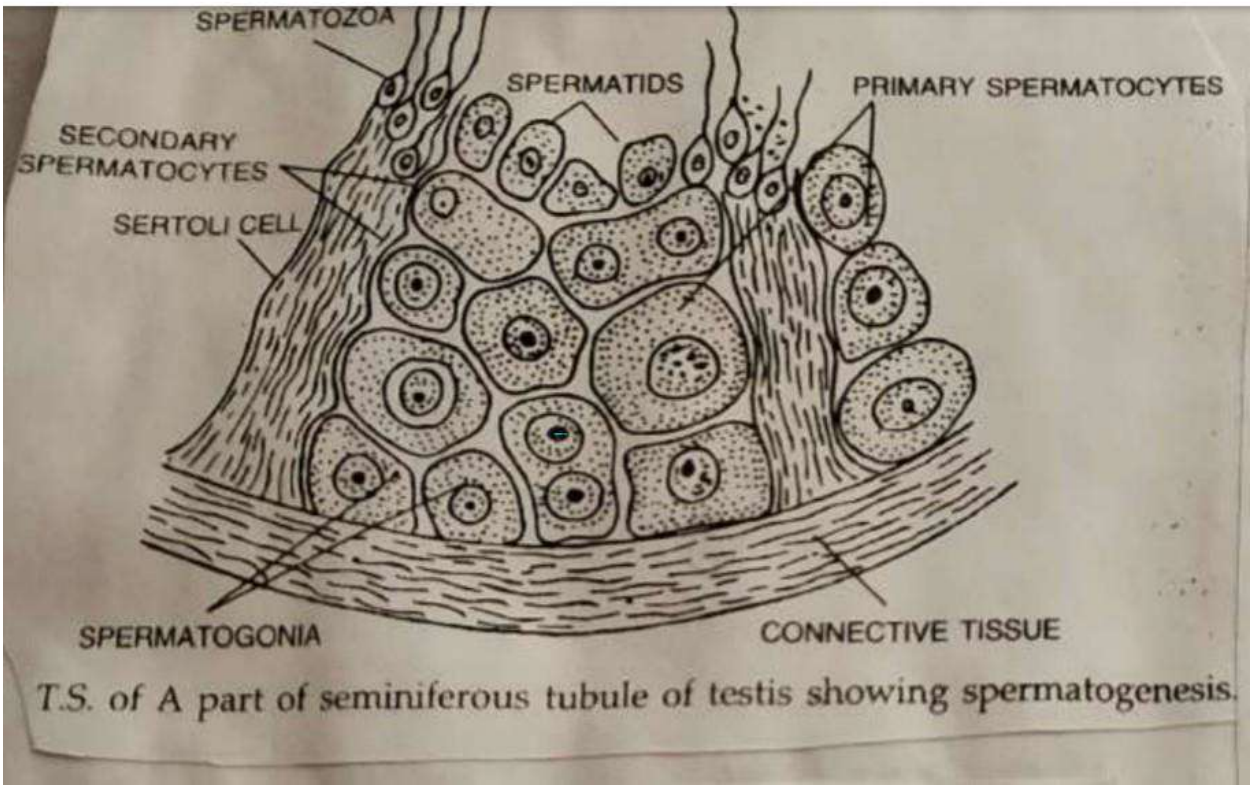

Fig. T.S of a part of a seminiferous tubule of testis showing spermatogeneis

Each spermatogonial cell is about 12 um in diameter and has a prominent nucleus .some spermatogonia act as stems cells called (type A sprematogoina) which are go On dividing and adding new cells which form a spermetogenic lineage but some spermetogonia move in word and enter in the growth phase (called type B)

B) Growth phase: It occurs after in last spermatogonial division in which a diploid spermatogonium increase in size (about twice) due to accumulation of nutritive material in the cytoplasm and forms diploid primary spermatocyte. During this the primary spermaoctocyte prepare itself to enter meiosis by replication of DNA.

C) maturation or meiotic division: in this phase the diploid primary spermatocytes undergoes meiosis-1 (reduction division) and forms two haploid cells called secondary spermatotocytes each containing half number of chromosome. It is immediately under go in meiosis_ ii (equationonal division) in each secondary spermatotocytes to form two

haploid spermatids. Each spermatid is small spherical cell with a nucleus and cytoplasm contains all the cell organelles So each diploid spermatogonium produces 4 haploid spermatid.

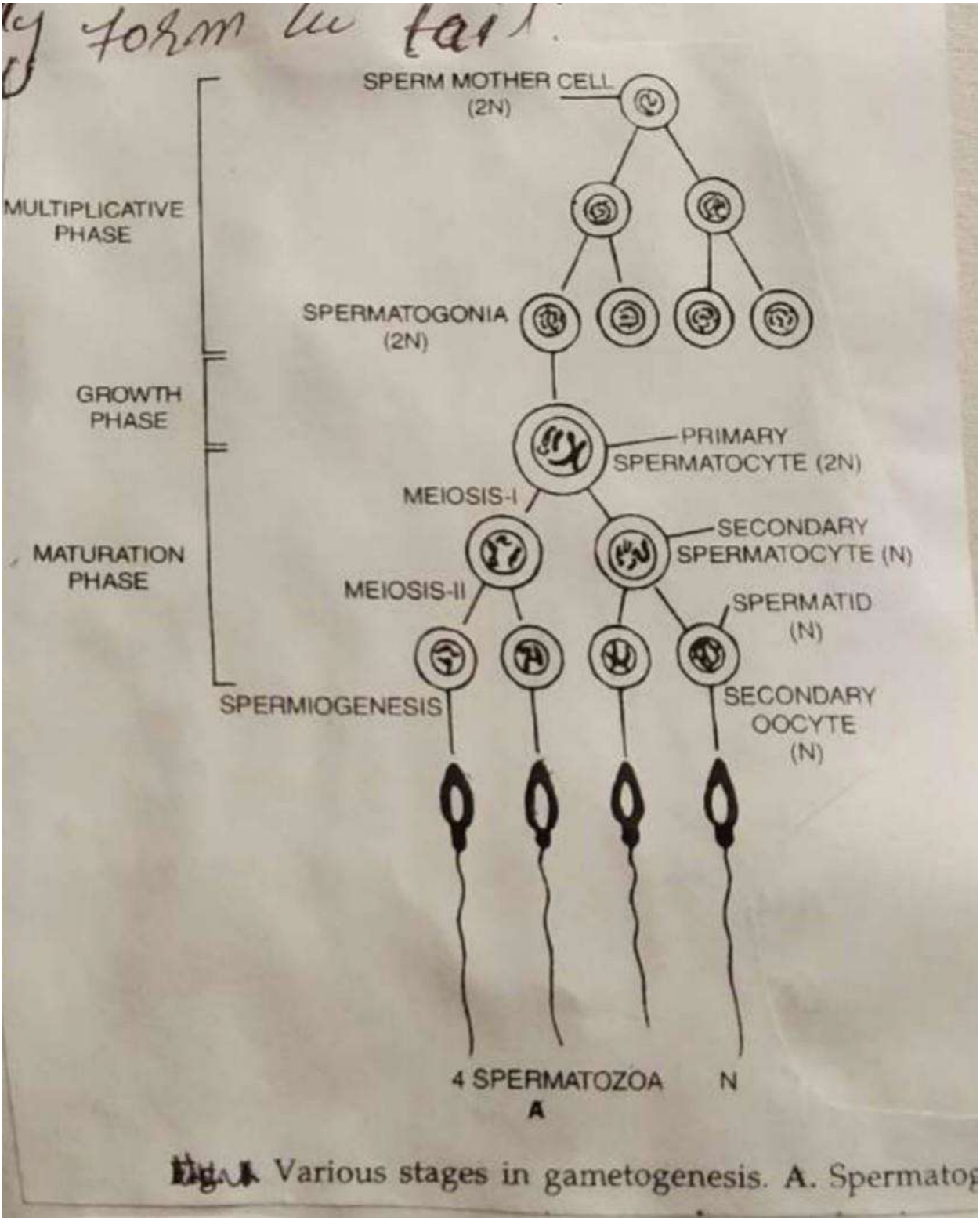

Fig. 1. Various stages in gametogenesis. A. Spermato

Fig. various stages in gametogenesis (Spermatogenesis)

2. Differentiation of spermatozoa: In this phase transfer, the non-motile rounded haploid spermatid into a functional motile spermatozoa. This process is called spermatogenesis. During this process super flous material of the developing spermatozoan are discarded and certain organelles are specialized. In this process change occur at the nuclear as well as cytoplasmic level. During this period the heads of developing sperms are embedded in the sertoli cell to get nourishment. By this process the formation of different parts of spermatozoan occur ie. Head, neck, middle part and tail.

(a) Formation of head: Nucleus and acrosome are the parts of head which are formed by three changes in .

1. Changes in Nucleus:

* Nucleus shrinks by loosing water from neucloplasm.
* Chromosomes are closely packed.
* RNA and other proteins are also eliminated.
* Histone protein is replaced by transitional protein and finally by protamines which contain large number of cystein residue. These form disulfide bonds which help in compacting the DNA. The nuclear membrane loss the pore complex. The nucleus changes from spherical form to elongated form and narrow form.

ii. **Acrosome formation:** The acrosome of a spermatozoan is derived from a part of Golgi apparatus of spermatid.The Golgi apparatus of an early spermatid consist of a series of cesternae which are arranged around small vascules.

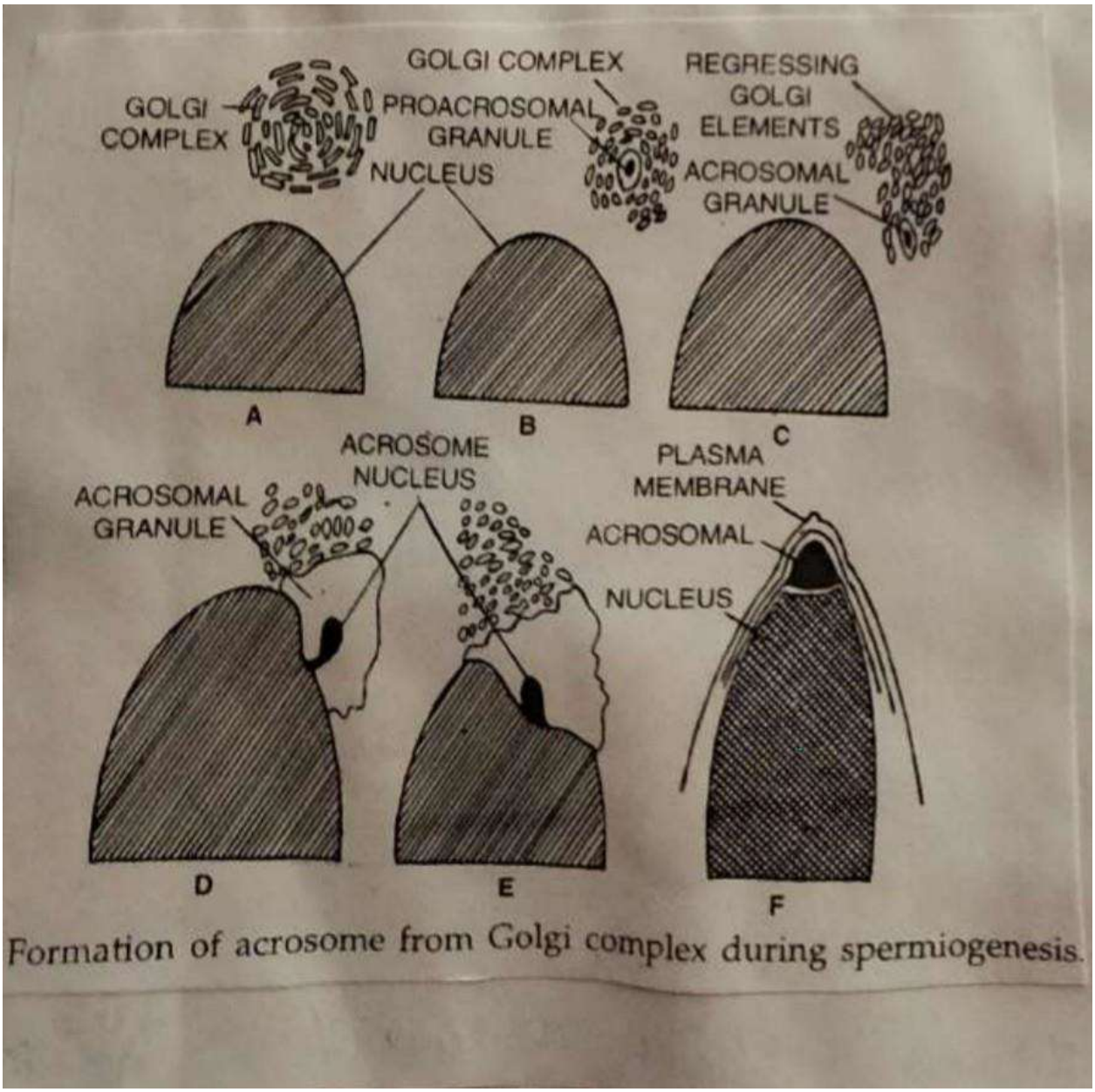

Fig. Formation of Acrosome from Golgi Complex during Spermiogenesis

During acrosome formation one or more vascules start enlarging and inside each vascules appears a sense body called proacrosomal granule. This vascule enlarge in volume by fusing with smaller vacules containing procrosomal granule. These granules join to form acrosomal

granule. Now this granule shift to the tip of elongating nucleus. Then this granule loses its liquid content and spread out of the

nucleus. So it forms the cap of spermatozoan. The remaining part of Golgi apparatus is reduced and discarded.

(b) Formation of neck: During the early stage of spermatogenesis two centriol shift just behind sperm nucleus. One of them comes lies in the depression in the posterior part of nucleus perpendicular and the longitudinal axis of the sperm . This centriol is called proximal centriol and second one lies just next to it along longitudinal axis of sperm is called distal centiole.

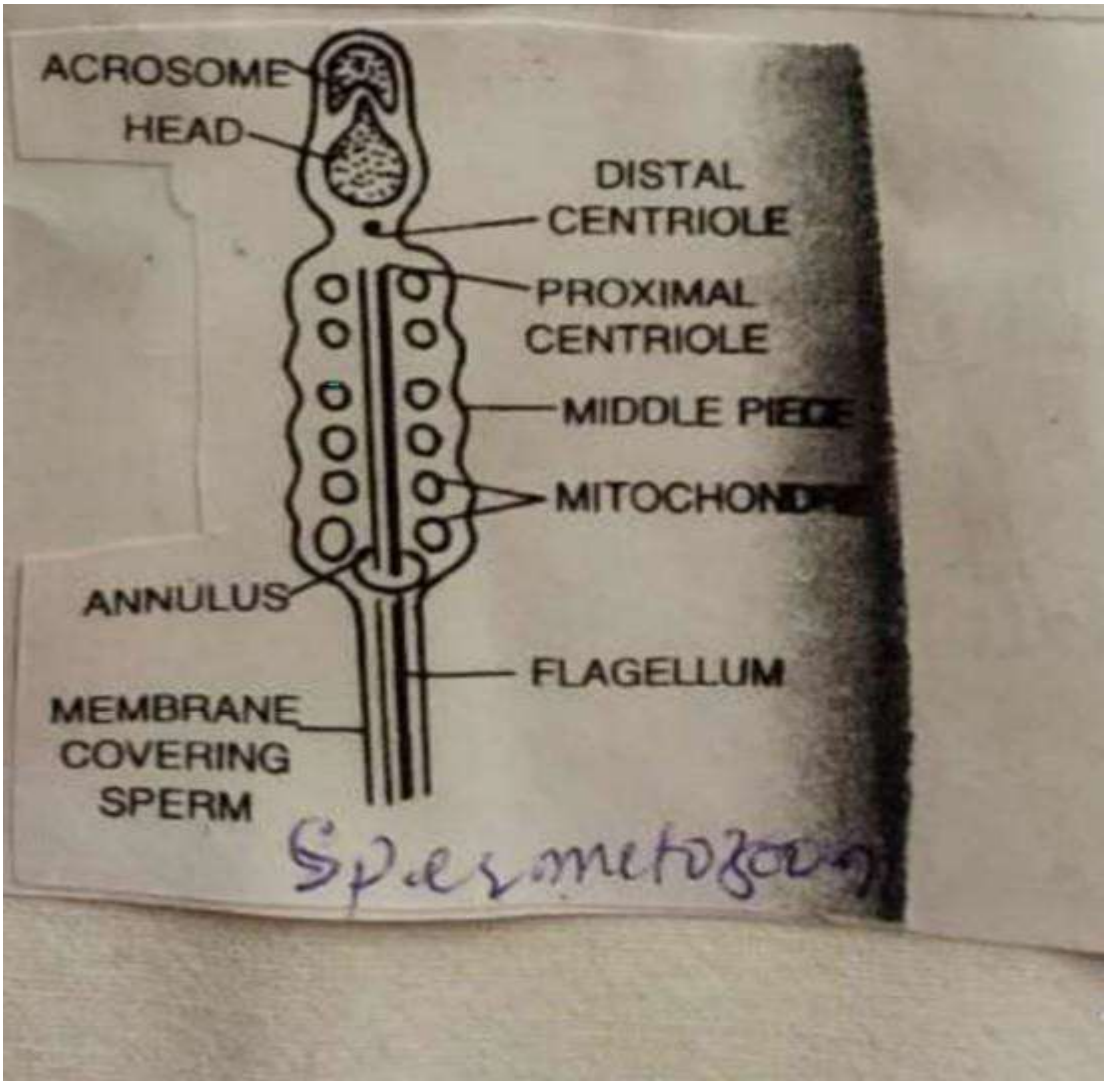

Fig. Spermatozoon

(c) Formation of middle piece : The mitochondria from different part of spermatid accumulate in middle piece around proximal part of axial filament and distal centriole. Then mitochondria get coiled form a sheath around axial filament and distal centiole.

(d) Formation of plasmamembrane and manchette: During the loss of cytoplasm form a condensed layer around periphery of acrosome , it is called manchette. An extremely thin layer also cover the remaining acrosome and nucleus.

(e) Formation of tail: Distal centriole give rise to contractile and microtubular structure called axoneme which gets surrounded by a cytoplasmic sheath. Both collectively form the tail.