INTRODUCTION TO EMBRYOLOGY.

DR EZUGWORIE, J O
MBBS, MSc, PhD, FWACS.

Introduction

Embryology is thought as

- General Embryology
- Pre-implantation/Implantation.
- Early embryogenesis
- Late embryogenesis
- Systemic Embryology

Outline

- Introduction
- Embryological Terms
- Testis
- Spermatogenesis:

- Spermatocytogenesis.
- Spermiogenesis

- Clinical Correlates

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Introduction

- **Embryology**, a branch of anatomy that deals with the formation, early growth and development of living organisms.
- The study of the development of living organisms from fertilization to birth.
- **Teratology** is a branch of embryology and pathology that is concerned with abnormal developments like congenital malformations.
  -Teratology deals with genetic and/or environmental factors that may produce birth defects.

Introduction

- The importance of embryology includes:
- **Understanding birth defects**: Embryology helps us comprehend the causes of congenital anomalies.
- **Reproductive medicine**: Embryology forms the basis of assisted reproductive technologies such as in-vitro fertilization(IVF).
- **Cancer research**: Embryonic developments can provide insights into cancer biology.
- **Regenerative medicine**: Embryology can inform strategies for tissue repair and regeneration.

INTRODUCTION

- Development begins with fertilization
- Fertilization is the union of sperm and oocyte (gametes), to form a zygote(one-cell embryo).
- Gametes are derived from primordial germ cells (PGCs)
- PGCs are formed in the **epiblasts** by 2nd week of development.
- PGCs move through the primitive streak during gastrulation.

INTRODUCTION

- PGCs then migrate to the yolk sac by 4th week.
- During the 4th week they migrate to the developing gonads, arriving by the 5th week.
- **Mitosis** increases PGCs number during migration and in the gonads.
- PGCs undergo **gametogenesis** in preparation for fertilization.
- Gametogenesis includes **meiosis** to reduce the number of chromosomes and **cytodifferention** to complete maturation.

Embryological terms

- The terms below are commonly used in discussions of developing humans (mostly Latin (L) or Greek (G) origins).

- **Zygote** (Gr. Zygotus – yoked) sperm and ovum unite to form a one cell embryo called zygote.
- **Oocyte** (L.Ovum, Egg) Female germ cell or sex cell produced in the ovaries
- **Blighted ovum -** early embryo whose development has ceased
- **Sperm** (Gr- sperma – seed)
- **Spermatozoon** (Gr. Spermatos – seed + zoon – animal)
- The sperm or spermatozoon – male germ cell produced in the testes (testicles). **Spermatozoa** – sperms

Embryological Terms

- **Fertilization/Conception Age-** the age of the embryo or fetus from the time of fertilization(conception)
- **Gestational age** : the age of the embryo or fetus from the first day of the last normal menstrual period (LMP).

- It is about two weeks longer than the fertilization age because the egg is fertilized about 2 weeks after the first day of menstruation

- **Cleavage** - the series of mitotic cell divisions of the zygote resulting in early embryonic cells called blastomeres.

- The size of the early embryo remains unchanged because the blastomeres become smaller at each cell division

Embryological Terms

- **Morula** (L. Morus- Mulberry) the embryo with 12 or more blastomeres at 3 to 4 days after fertilization.
- It resembles fruits of mulberry tree
- **Blastocyst** (Gr. Blastos – germ, L.Cysis—bladder-- embryo with fluid filled cavity. T he centrally located cells as the inner cell mass or embryoblast, the primordium of embryo
- **Implantation** – the process by which the blastocyst attaches to the endometrium and embeds in it
- The pre-implantation period of embryonic development is the time between fertilization and the beginning of implantation.
- The period is nearly 6 days

Embrological terms

- **Blastula-** An early embryo with hollow fluid filled rounded cavity bounded by a single layer of cells(outer cell mass).

- It has an inner cell mass.

- **Neurula**- the embryo at the stage of neurulation or formation of the neural tube.
- **Embryo** (Gr, embryon) this refers to early stage of developing human being which extends to the end of the 8^{th} week.

- At this stage the beginnings of all major structures are present.

- **Gastrula**- a three layered or trilaminar embryonic disc.

- The three germ layers differetiate into the tissues and organs of the embryo.

Embryological Terms

- **Conceptus** (L. concepto- derivatives of a zygote) this refers to embryo and all structures that develop from it – placenta,amnion,chorion and yolk sac.
- **Primordium** (L.Primus, first + ordium – to begin) this refers to first recognizable indication for development of an organ or structure.
- **Fetus** (L. Unborn offspring) the developing human after embryonic period.
- The fetal period is 9^{th} week to birth. Tissue and organ formed during the embryonic stage differentiate and grow.

Embryological Terms

- **Trimester**; a period of three calendar months during a pregnancy.
- The first trimester (12week, is most critical because embryonic and early fetal development is occurring)
- **Abortion**; this means a premature stoppage of development or premature expulsion of a conceptus from the uterus or expulsion of an embryo or fetus before it is viable (capable of living outside the uterus)
- **Congenital anomalies/malformations**; these are birth defects or abnormalities of development present at birth

Genetics and human development - Revision

- Mendel’s principles of inheritance:
- zygotes contain all the genetic information necessary for directing the development of a new human being
- Chromosomes and chromosomal abnormalities
- Mitosis and meiosis
- Human genome

EMBRYO/FETUS

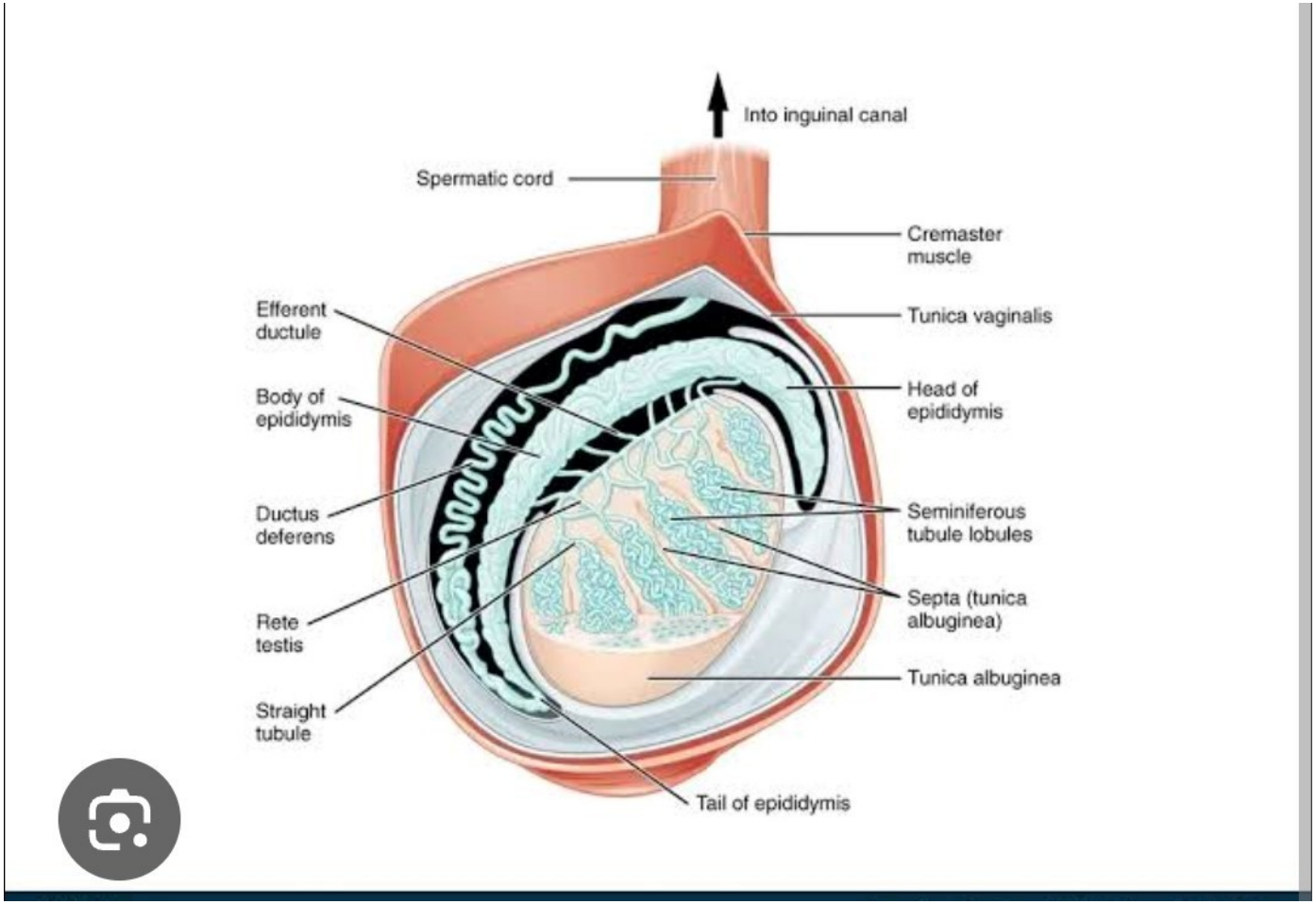
- Embryonic development ends on day 56 (end of 8th week)
- Fetal period begins on day 57 (9th week) and ends when the fetus is completely outside the mother.

- Ultrasonography can be used to assess the stages of embryonic development and fetal wellbeing

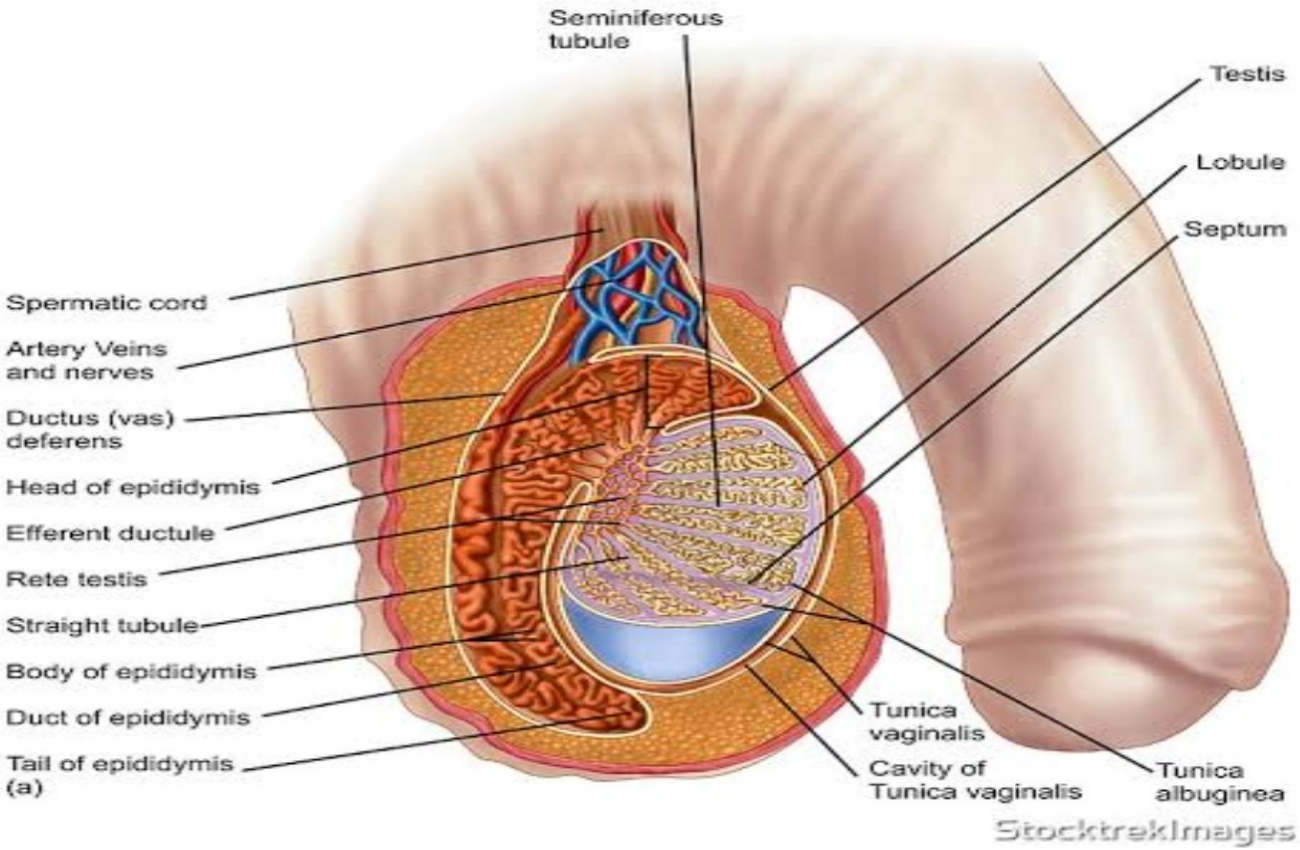
TESTIS

- A male gonad in the scrotum (pouch of skin)
- Invested by 3 coats. From inside – out: tunica vasculosa, tunica albuginea and tunica vaginalis, then subcutaneous tissue, dartos muscle and skin
- Tunica albuginea, at the posterior border of the testis forms mediastinum testis
- Series of septa radiate from the mediastinum testis to divide the testis into 200-300 lobules.
- The lobules intercommunicate and vary in size.
- Each lobule contains 1-3 convoluted seminiferous tubules
- The tubules begin blindly or by anastomatic loops.
- The ends of the tubules join some thirty short collecting tubules called straight seminiferous tubules.

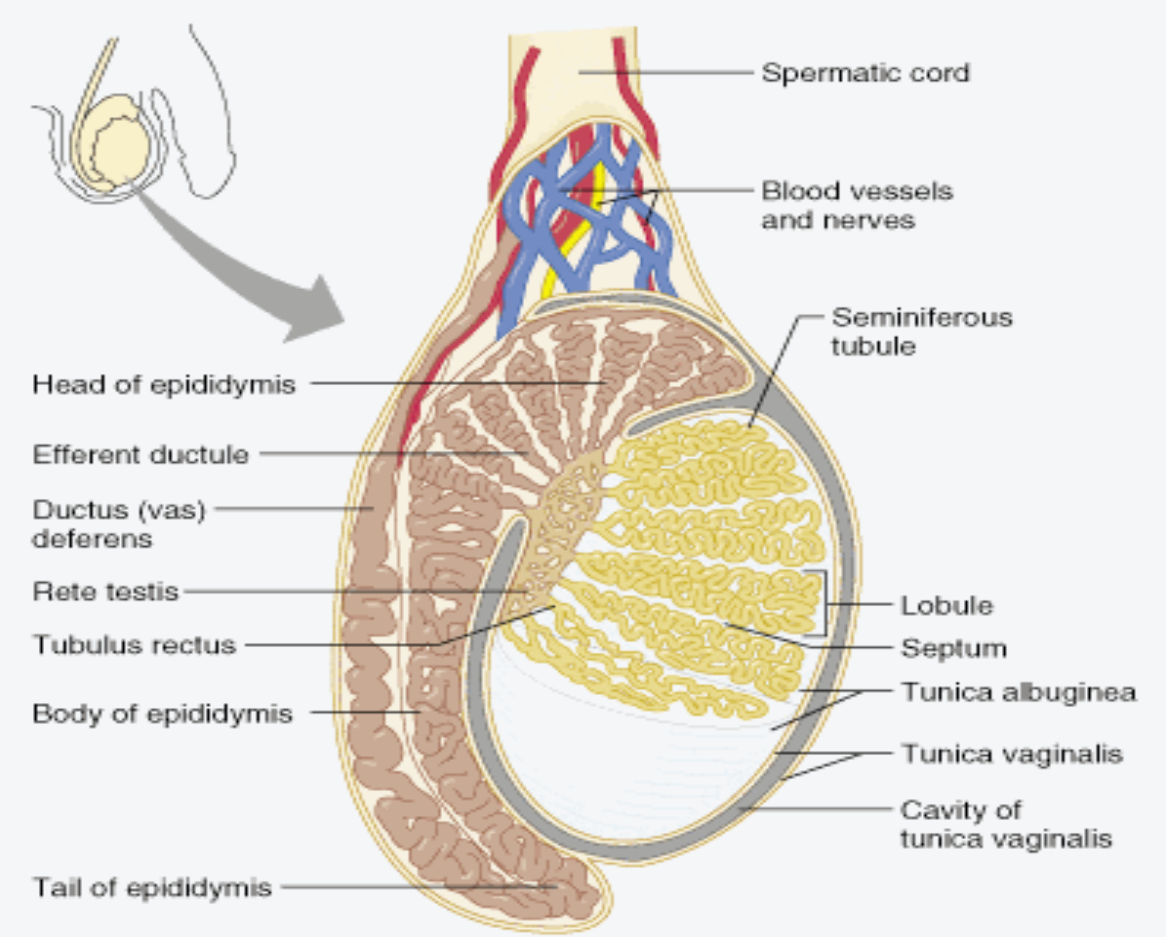
TESTICULAR ANATOMY



TESTICULAR ANATOMY



Testis



Testis

- The straight seminiferous tubules open into rete testis (intercommunicating network of spaces).
- Seminiferous tubules are embedded in a delicate connective tissue.
- The connective tissue contains **interstitial cells of Leydig** (**Leydig cells**).
- The Leydig cells are the source of testosterone.
- Each seminiferous tubule has a basement membrane.

Testis

- The basement membrane has set cells consisting of two elements:
- Spermatogenic cells and other supportive cells (sustentacular cells of Sertoli).
- The supportive cells or sustentacular cells of Sertoli provide mechanical support, protection and probably nutrition for the developing germ cells.
- In an active testis, the spermatogenic group includes a whole array of cells derived from primordial germ cells (spermtatogonia).
- The derived cells are the spermatocytes, spermatids, then the spermatozoa (sperms).

Spermatogenesis

- The entire sequence of events leading to transformation of primordial germ cells into spermatozoa (sperms).
- It begins at puberty, continues into old age.
- Descriptively divided into:

- Spermatocytogenesis.
- Spermiogenesis.

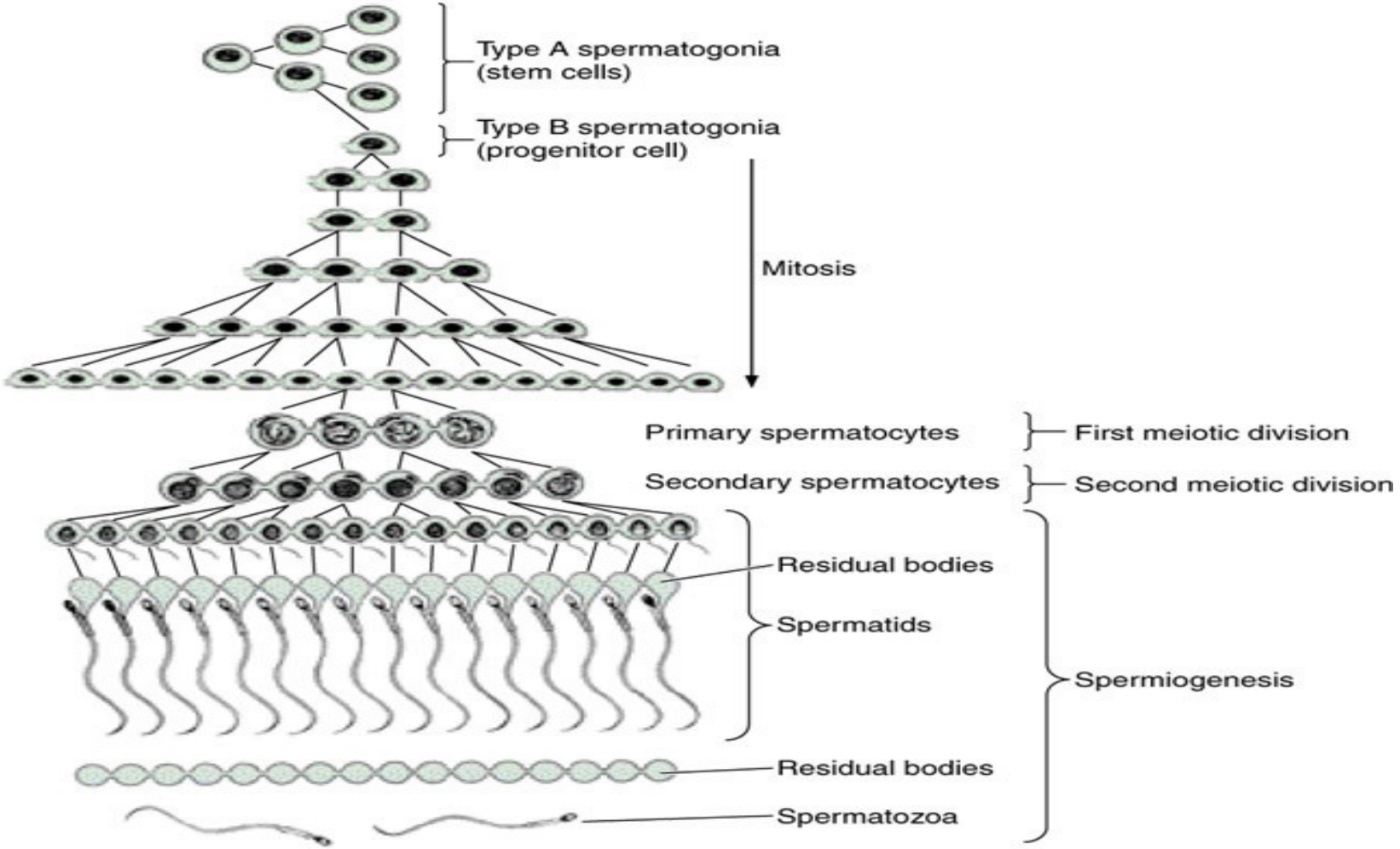
Spermatocytogenesis

- The process by which primordial germ cells or spermatogonia become spermatocytes.
- It involves **mitotic** and **meiotic divisions**
- About the time of puberty:
- The **sex cords** acquire lumen and become the **seminiferous tubules**.
- The primordial germ cells(PGCs) give rise to **spermatogonia.**
- **Sp**ermatogonia are of two types; **type A and type B spermatogonia.**

Spermatocytogenesis

- **Type A** spermatogonia divide by **mitosis** to provide a continuous reserve of stem cells.
- Some **type A cells** give rise to successive and progressively more **differentiated** generations of **type A spermatogonia.**
- The generations range from 4 to 7.
- **Type B** spermatogonia form on completion of the last generation/division of the type A cells.

Spermacytogenesis



Spermatocytogenesis

- **Primary spermatocytes** are formed when Type B spermatogonia undergo mitosis.
- They are **diploid cells**.
- Secondary spermatocytes are formed by primary spermatocytes after:
- 22 days in prophase
- and rapid completion of **meiotic 1 division**
- **Spermatids** form after **second meiotic division** by the secondary spermatocytes
- Both secondary spermatocytes and spermatids are **haploid cells**

Spermatocytogenesis

- The daughter cells of spermatogonia up to spermatids are connected by **intercellular bridges**

- This is due to incomplete division of the cytoplasm.

- Only the most primitive type A spermatogonia complete cytokinesis to maintain stem cell population.
- Spermatogonia up to spermatids are embedded in **deep recess of Sertoli cells.**
- Sertoli cells assist in the release of mature spermatozoa.

Spermiogenesis

- The differentiation process that leads to the transformation of spermatids into spermatozoa.
- The changes include:
- Formation of acrosome
- Condensation of nucleus into a dense mass(head)
- Formation of neck, middle piece and end piece
- Shedding of most of the cytoplasm
- In humans, it takes about 74 days for a spermatogonium to develop into a mature spermatozoon or mature sperm

Clinical correlates

- Approximately 300 million sperms are produced daily.
- About 10% of the sperms have defects:
- Some joined, dwarfs, giants or with defective head or tail
- Such sperms with abnormal morphology lack normal motility, and may not fertilize oocytes.

THANK YOU.