Primary Sex Organ

TESTIS

Testis (Testicle):

- Two oval organs

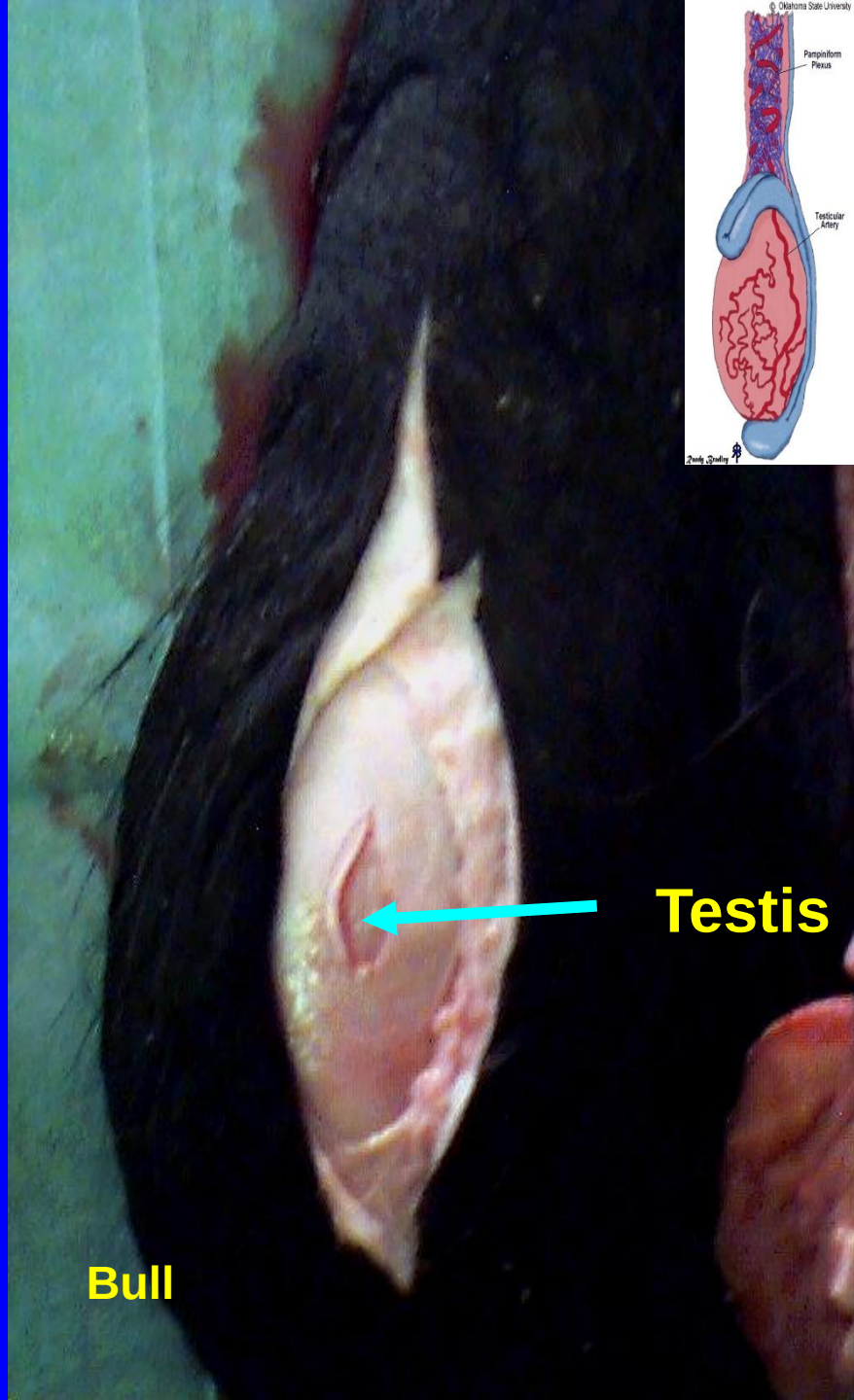
- Suspended by

Spermatic cord

in a pendulous abdominal pouch called

Scrotum, *that is*

divided into 2 compartments by median septum



Spermatic cord:

= A cord-like structure

- Consists of:

1- **Ductus Deferens**
and accompanying

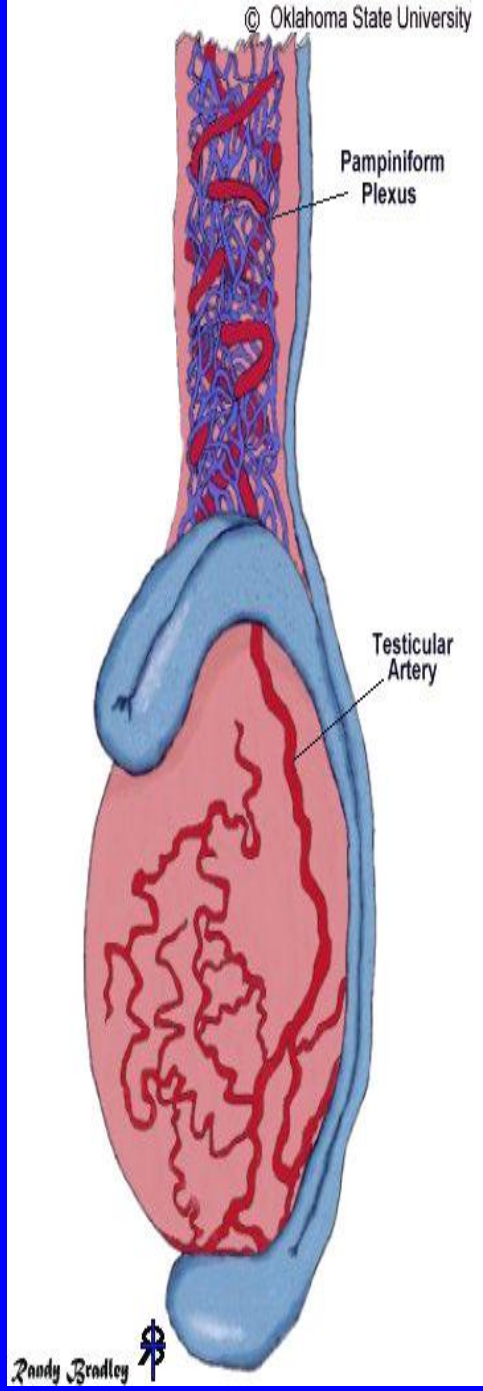
2- Testicular **arteries**, **veins**, **nerves**, and **lymphatic** vessels (that passes from the abdominal cavity through the inguinal canal down into the scrotum to the back of the testicle)

N.B.:

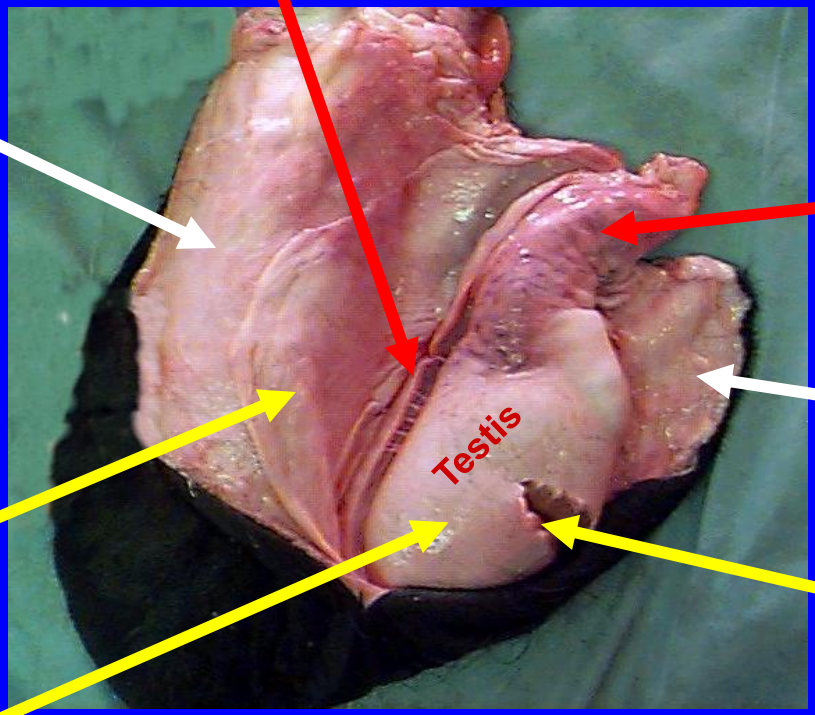
- Testicular artery arises from the abdominal aorta just below the renal artery

- Testicular veins drain to the inferior vena cava

Q: What is the role of testicular artery and veins in thermoregulation mechanism of testis?



Scrotal layers:



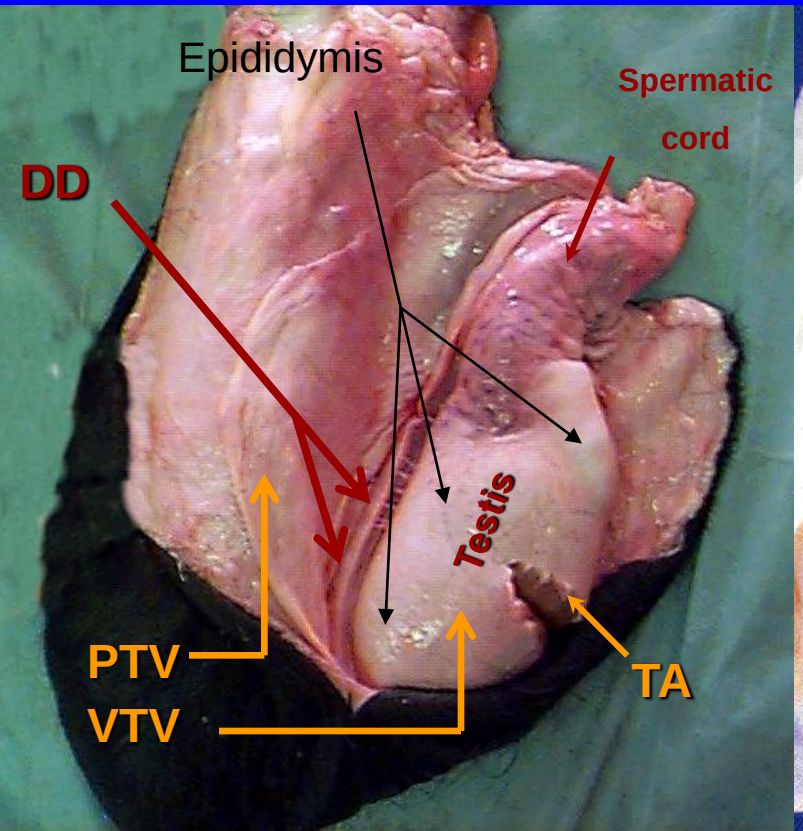
Testicular Structure:

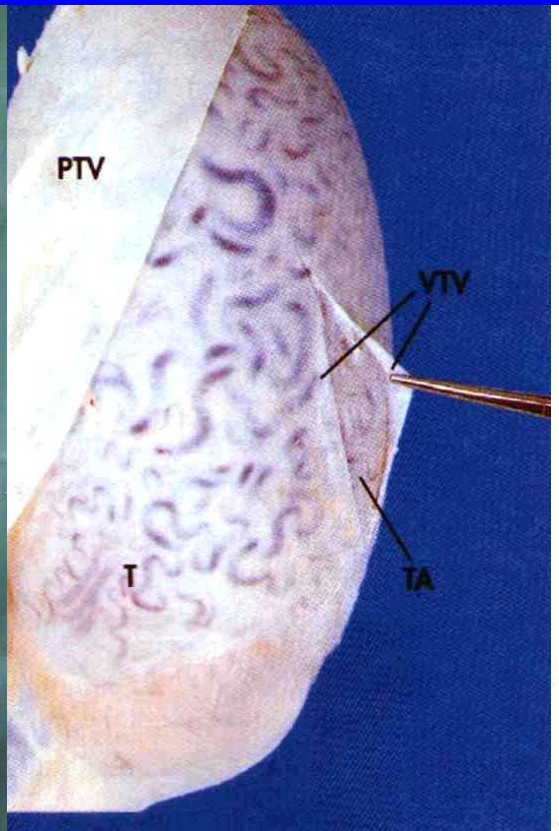
(A) Testicular Stroma:

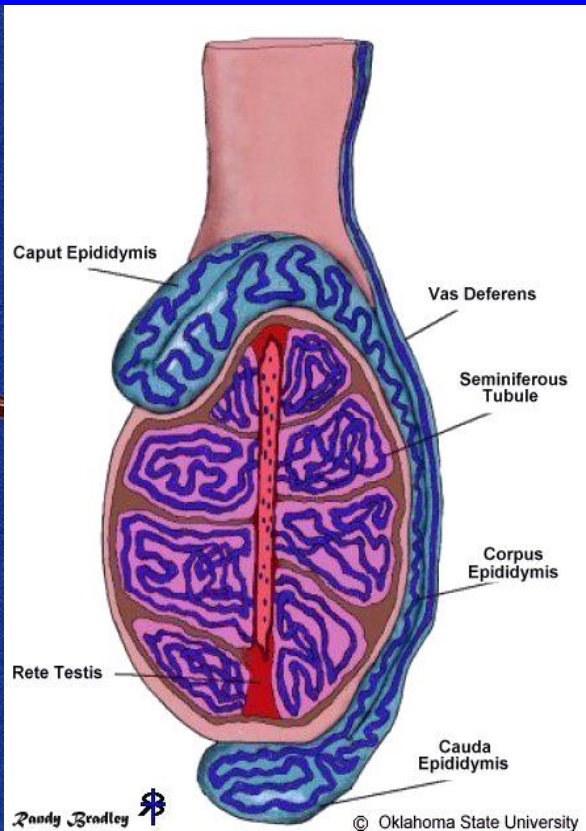
- Tunica vaginalis (parietal and visceral):
- Tunica albuginea (TA) - Mediastinum testis

(B) Seminiferous Tubules:

(C) Rete Testis:





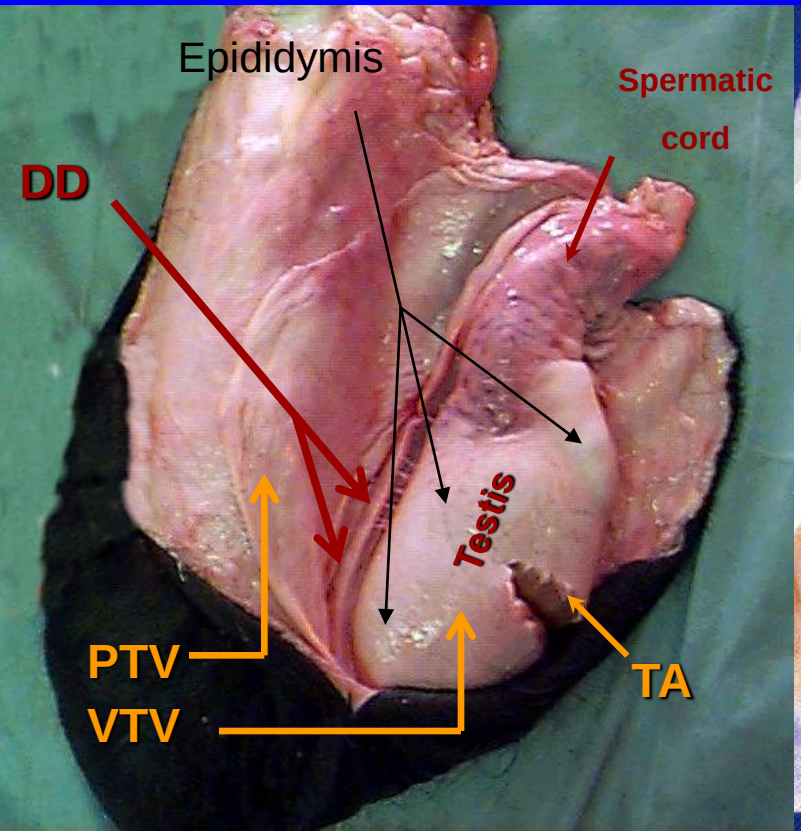


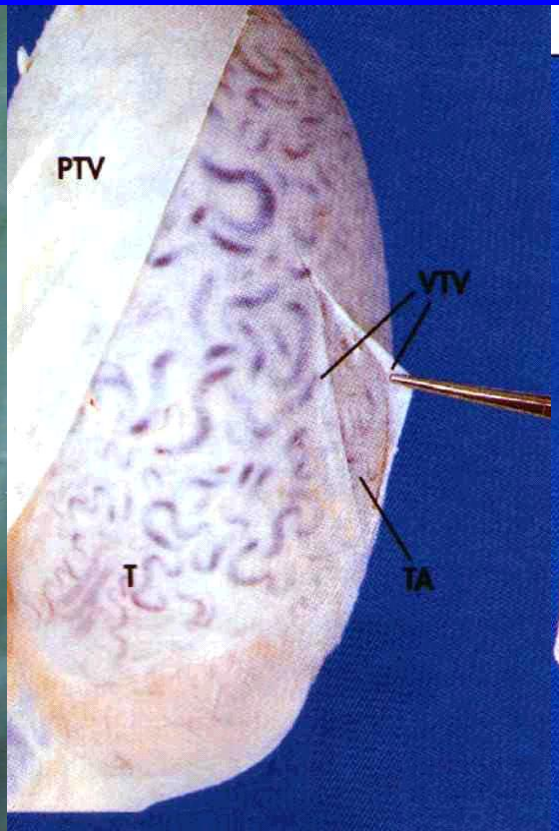
Testicular Stroma

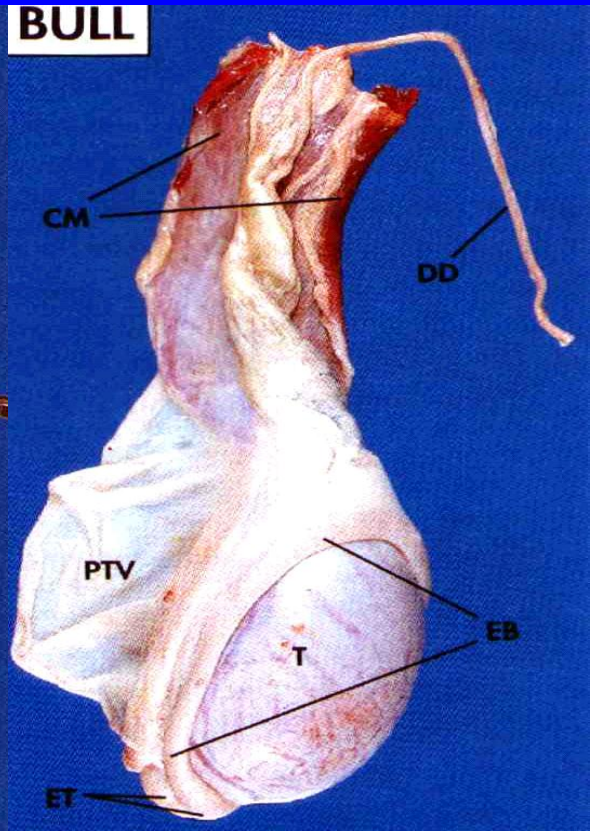
(Tunica Vaginalis - Tunica Albuginea - Mediastinum Testis)

1- Tunica vaginalis:

- A sac-like extension of the peritoneum that descended into the scrotum with the testes
- Covers the tesis anteriorly
- Composed of two layers: parietal (PTV) and visceral (VTV).

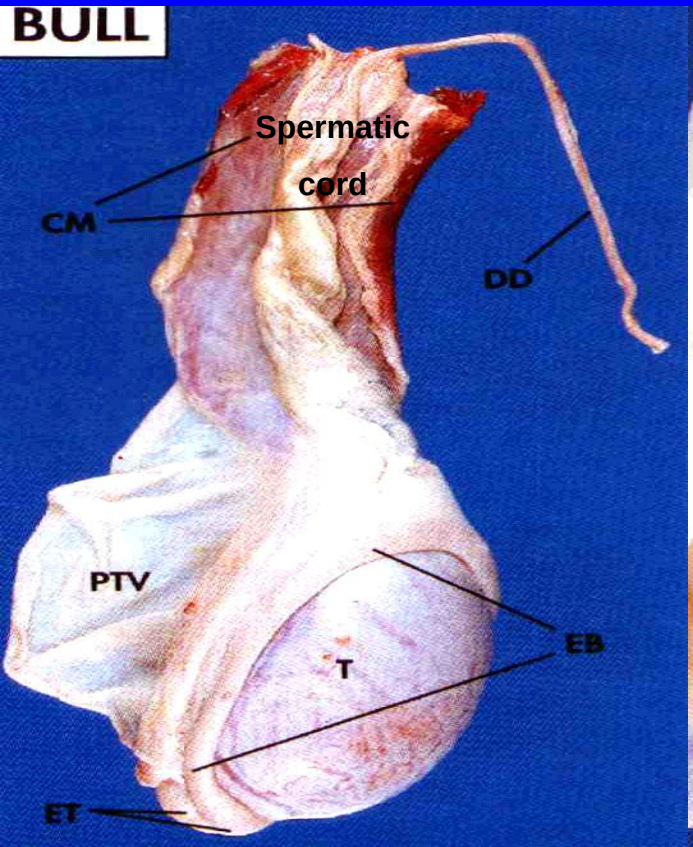


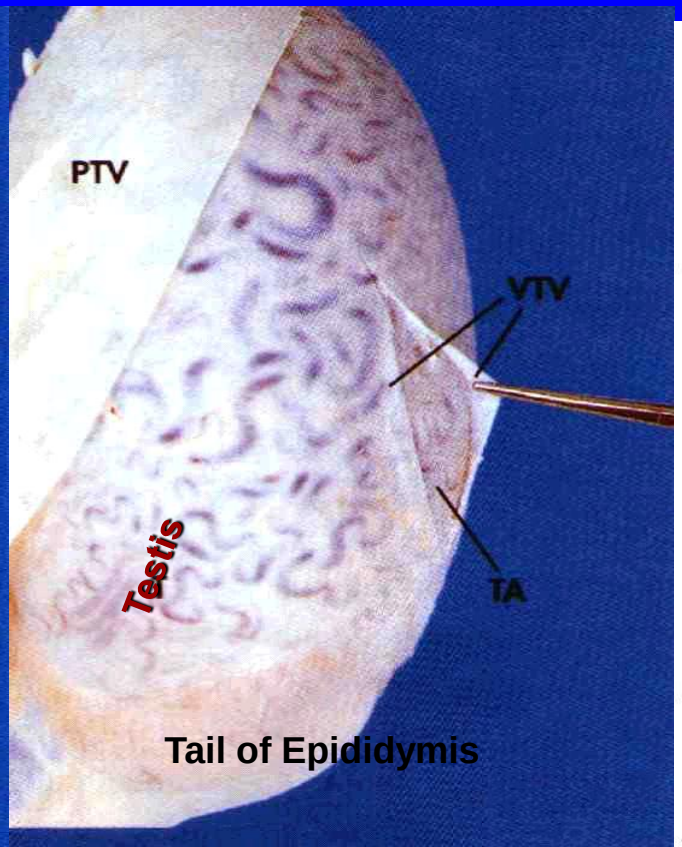


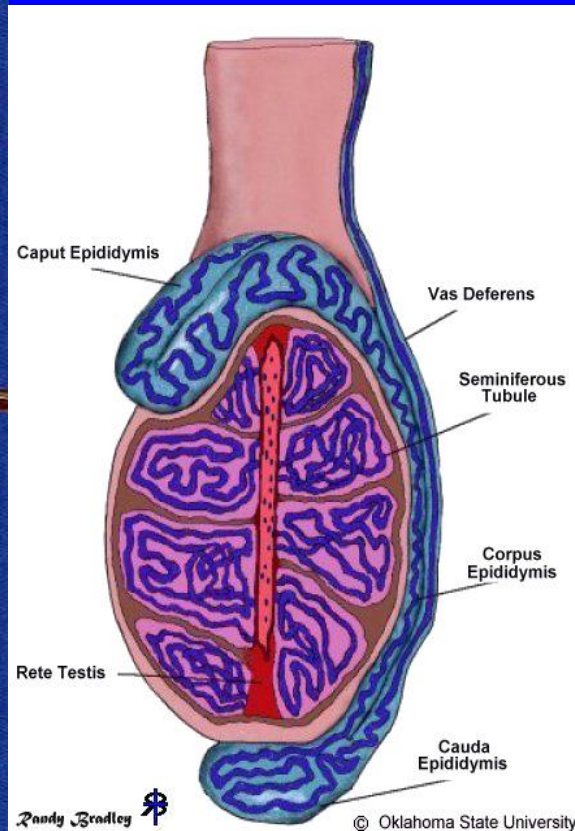


2- Tunica albuginea (TA)

- ***White*** fibrous capsule
- surround the testis
- from which arise septa that divide the testis into compartments (lobules) containing seminiferous tubules which drain into network of channels called **Rete Testis**

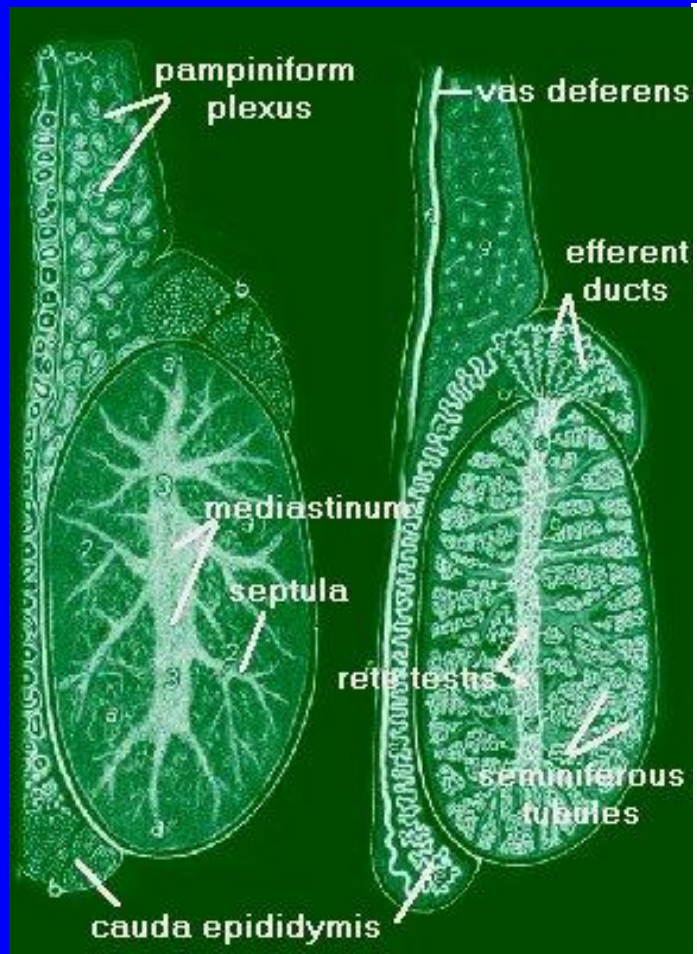


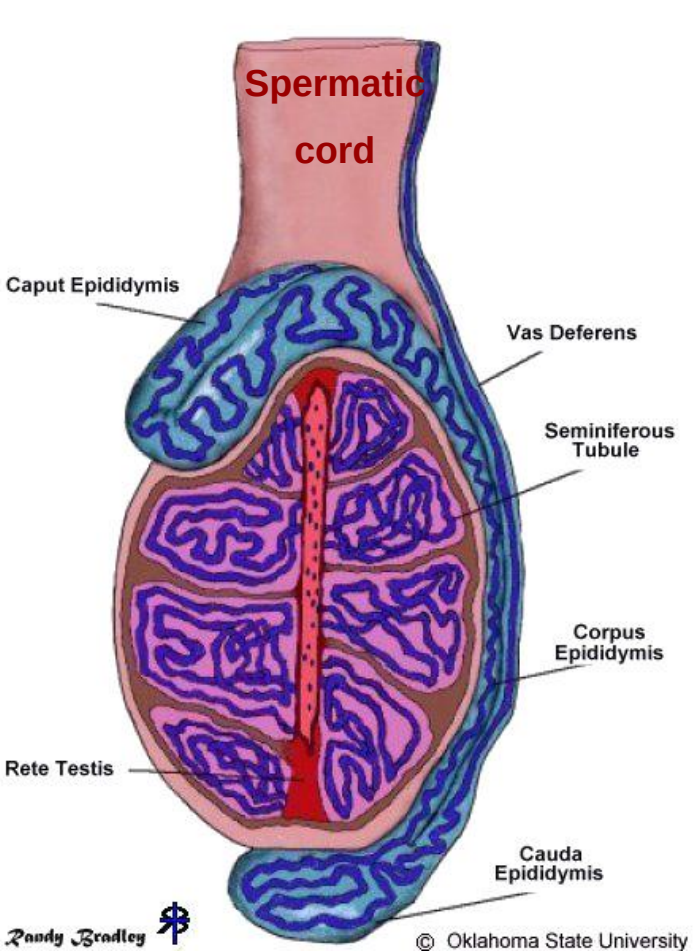




3- Mediastinum testis:

- an area of loose conective tissue
  - formed by converging septae
  - surround rete testis

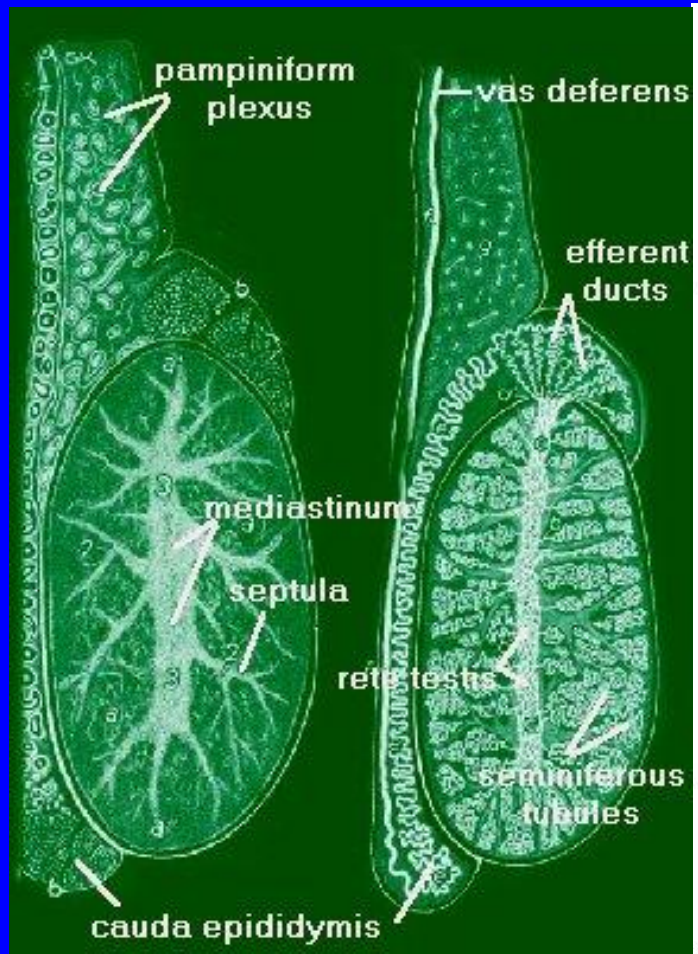


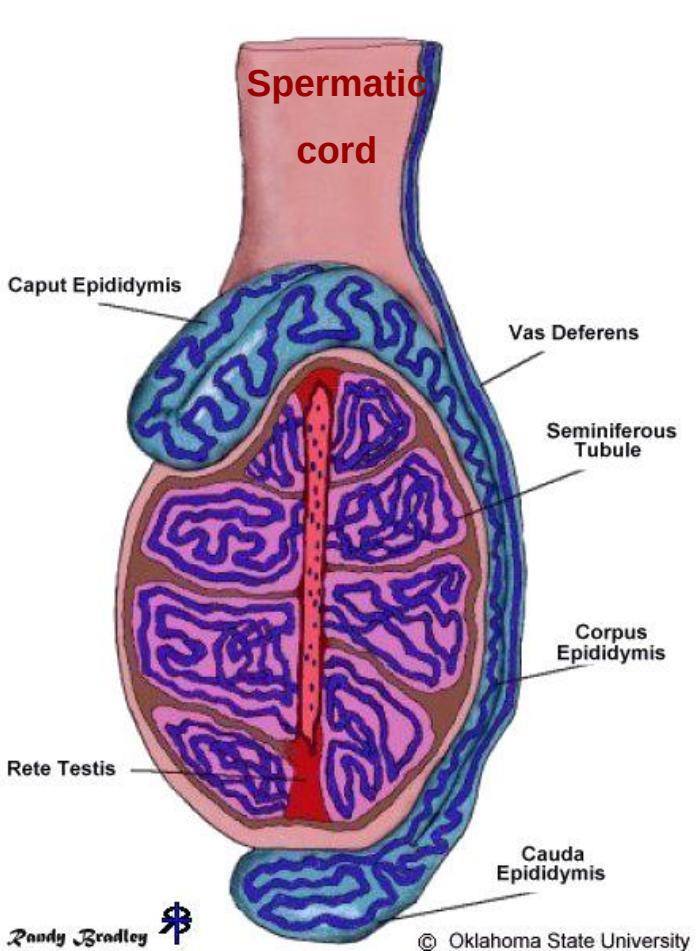


Seminiferous Tubules

Seminiferous tubule:

= *Structural and functional unit of the testis*





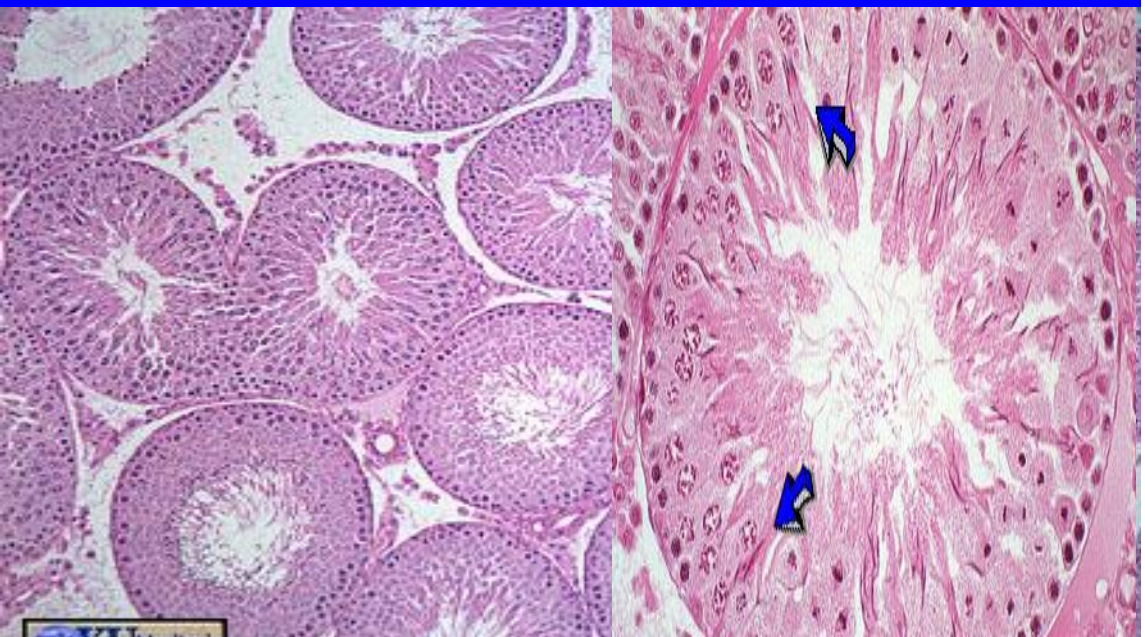
Cross-section of the seminifrous tubules:

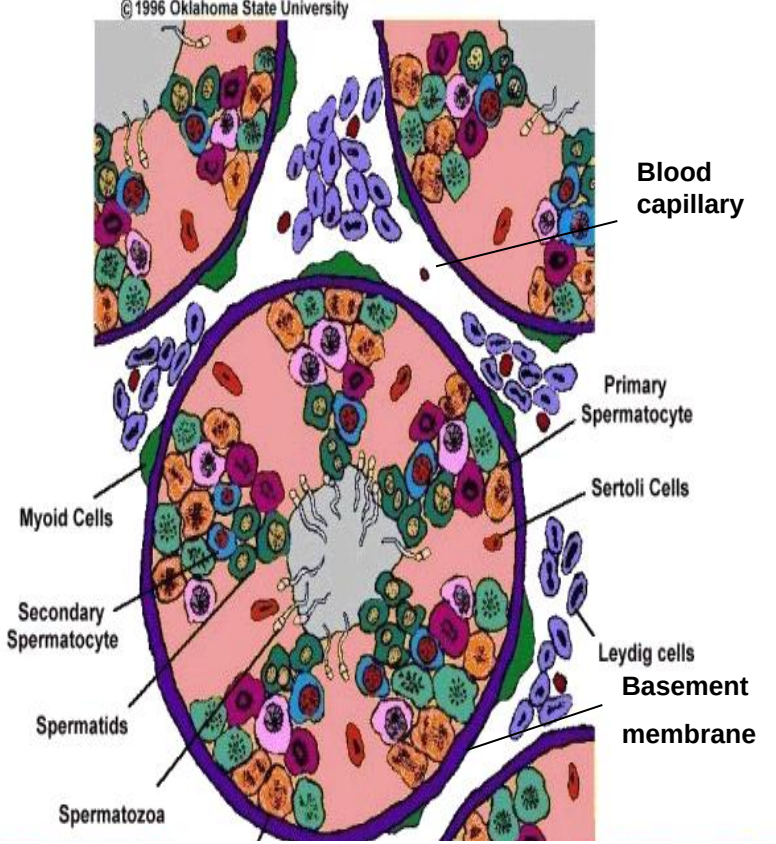
1- Basement membrane:

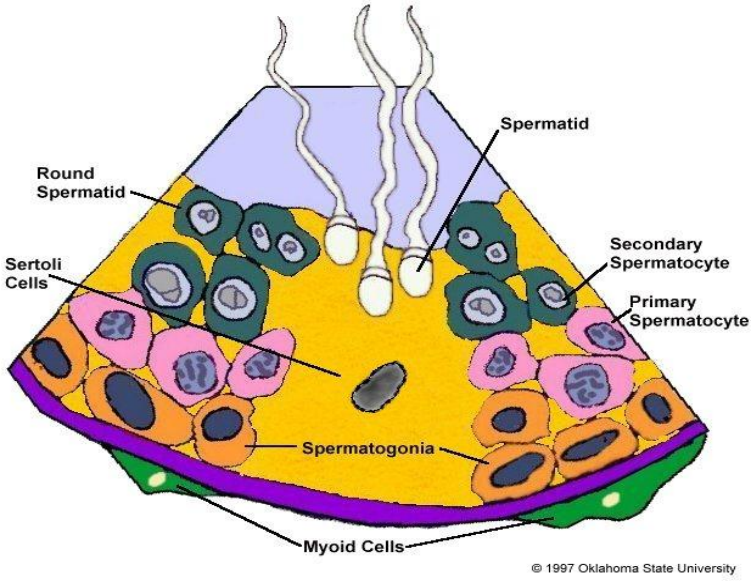
- Stratified epitheilium supported by:

a- connective tissue

b - smooth muscle cells (**Myoid cells**) which contract to propel spermatozoa toward rete testis







Cross-section of the seminifrous tubules:

2- Three types of cells:

A- Germinal epithelium:

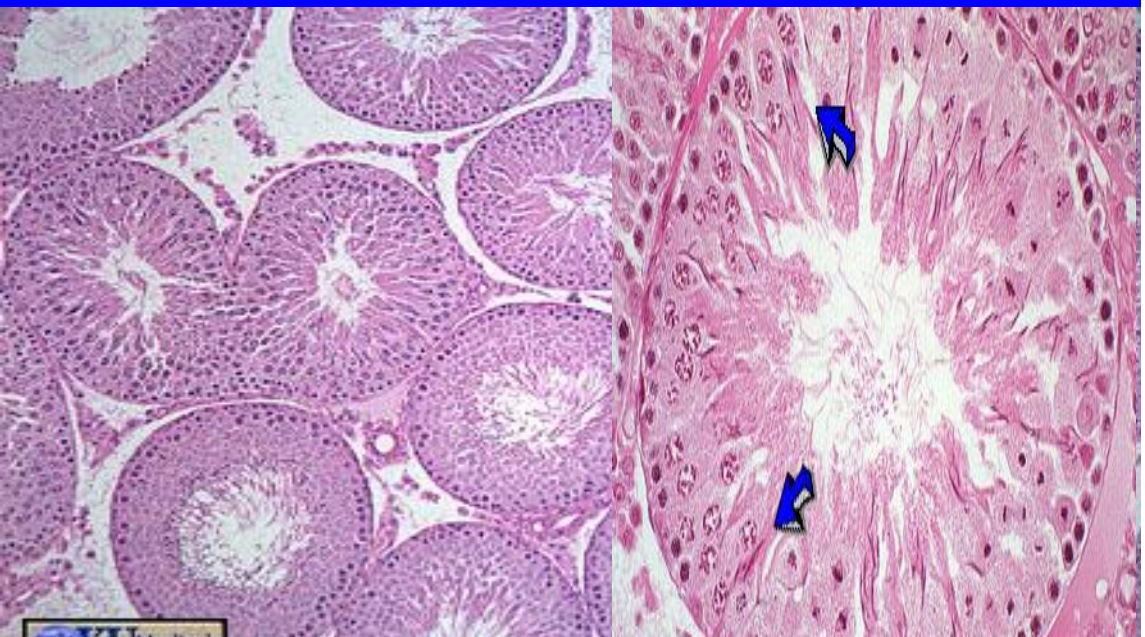
- Thick layers of germ cells line the basement membrane of semineferous tubule.

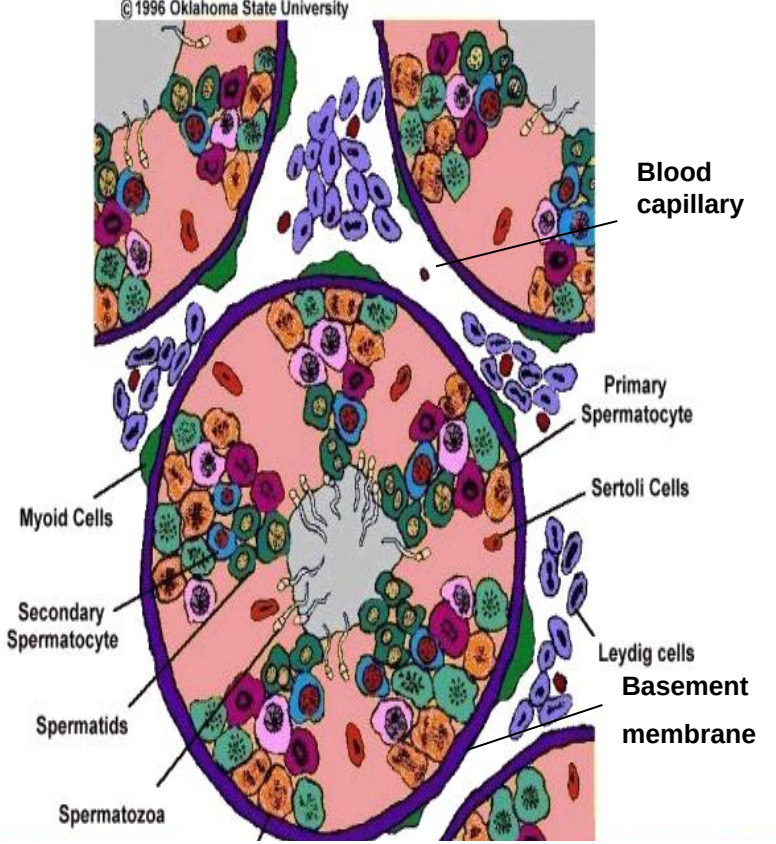
B- Sustentacular (Sertoli) cells:

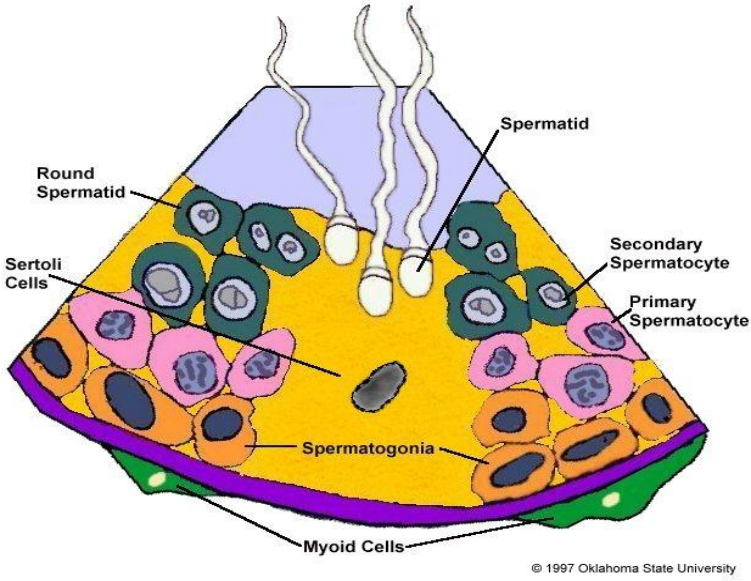
- Large pyramidal cell extending from the basal lamina to the lumen.

C- Interstitial (Leydig) cells:

- Clusters of cells between the seminiferous tubules in the testicular stroma







Rete Testis

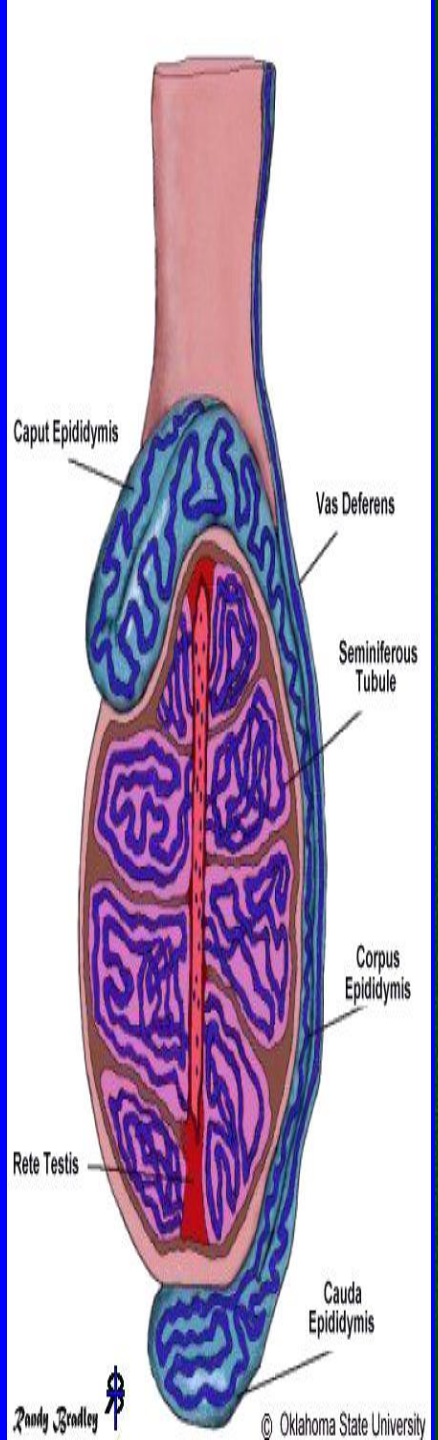
Rete Testis:

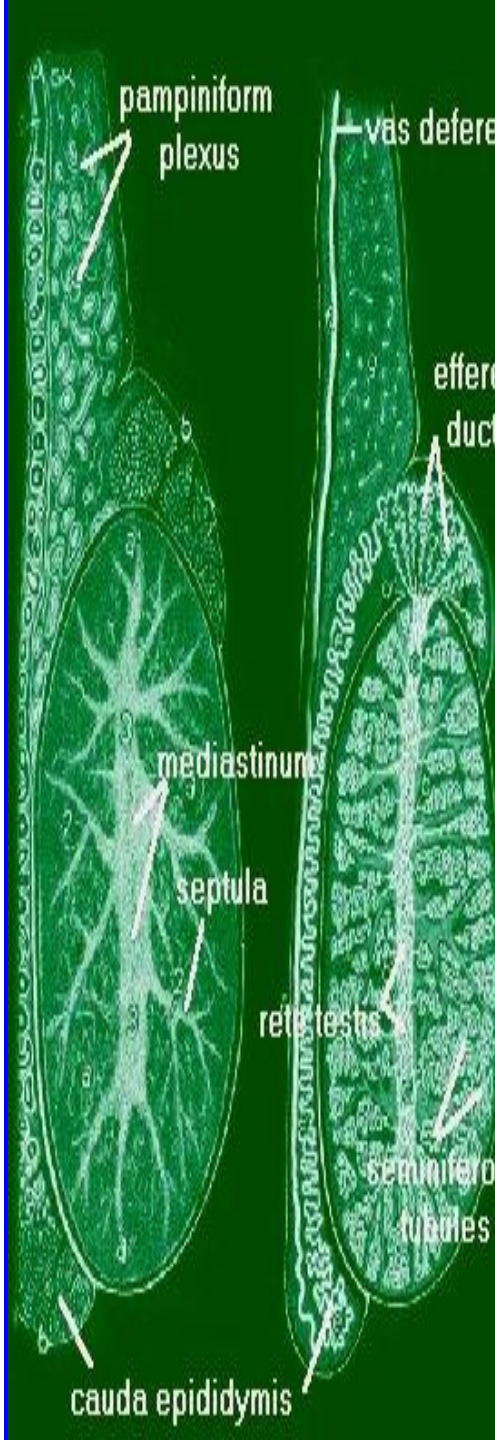
= Network of channels:

- embedded in the mediastinal CT.
- lined with simple squamous, cuboidal, or columnar epithelium
- surrounded with myoid cells.

Function:

- Drain into efferent tubules
- Secrete part of testicular fluid which combines with fluid produced by seminiferous tubules formed in testicular fluid





FUNCTIONS of the Primary Sex Organ (TESTIS)

Functions of the Testis:

1- **Germinal epithelium?**

Exocrine function = Production of sperms
(Spermatogenesis)

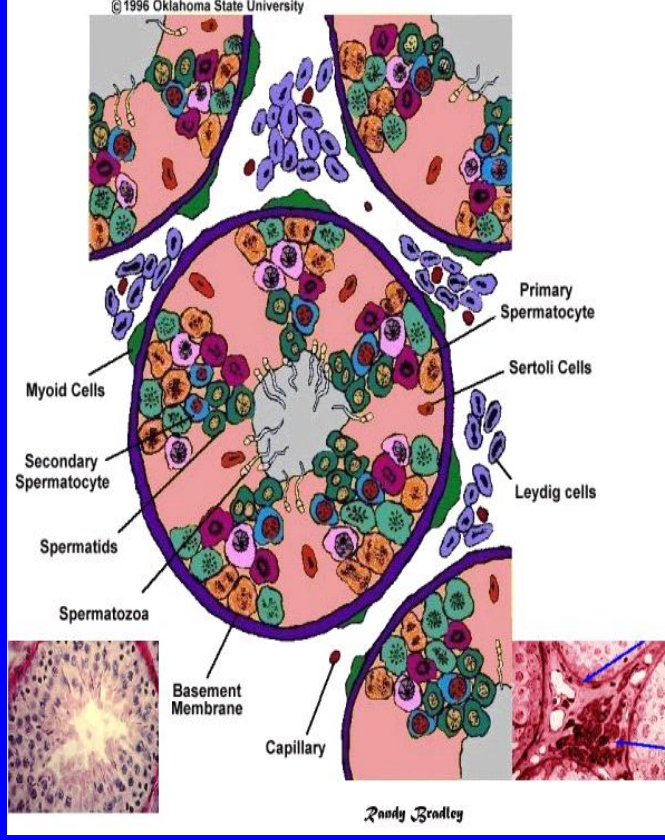
2- **Interstitial (Leydig) cells?**

Endocrine function = testosterone

3- **Sustentacular (Sertoli) cells?**

Promote sperm cell development

4- **Transport sperm out of the testis?**



Exocrine Function of the Testis

(SPERMATOGENESIS)

- What is spermatogenesis?

= Process of producing sperm with half the number of chromosomes (hapliod).

= *Multiplication*, *maturation* and *differentiation* of

Germ stem cells **(Spermatogonia)**

resulting in the formation of the

Male gametes **(Spermatozoa)**

- Where does spermatogenesis occur?

Spermatogenesis occurs in the

Semineferous tubules

- Spermatogenesis **begins** at ***Puberty*** after

a long preparatory period of "prespermatogenesis“

in the fetus and the infant

- What are the phases of Spermatogenesis?

(A) Spermatocytogenesis:

1) Proliferative phase (Mitosis):

Spermatogonium (2N) → Primary spermatocytes (2N)

2) Reduction phase (Meiosis):

Primary spermatocytes → Spermatids (N)

(B) Spermiogenesis:

Spermatids → Spermatozoa

- Phases of Spermatogenesis:

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(B) Spermiogenesis:

Spermatids → Spermatozoaa

(A) Proliferative phase

(Mitotic divisions):

(Resting spermatogonium → Primary Spermatocytes)

* Stem cell spermatogonia (at the basement mebrane of seminefrous tubule

Mitosis

* Type A spermatogonia

Mitosis

1) Resting Type AO spermatogonia: stay at the basal surface and act as precursor = stem cells (to maintain the population of stem cell pool).

2) Active Type A:

Mitosis

* more Type A (A1→ A2 → A3),

Mitosis

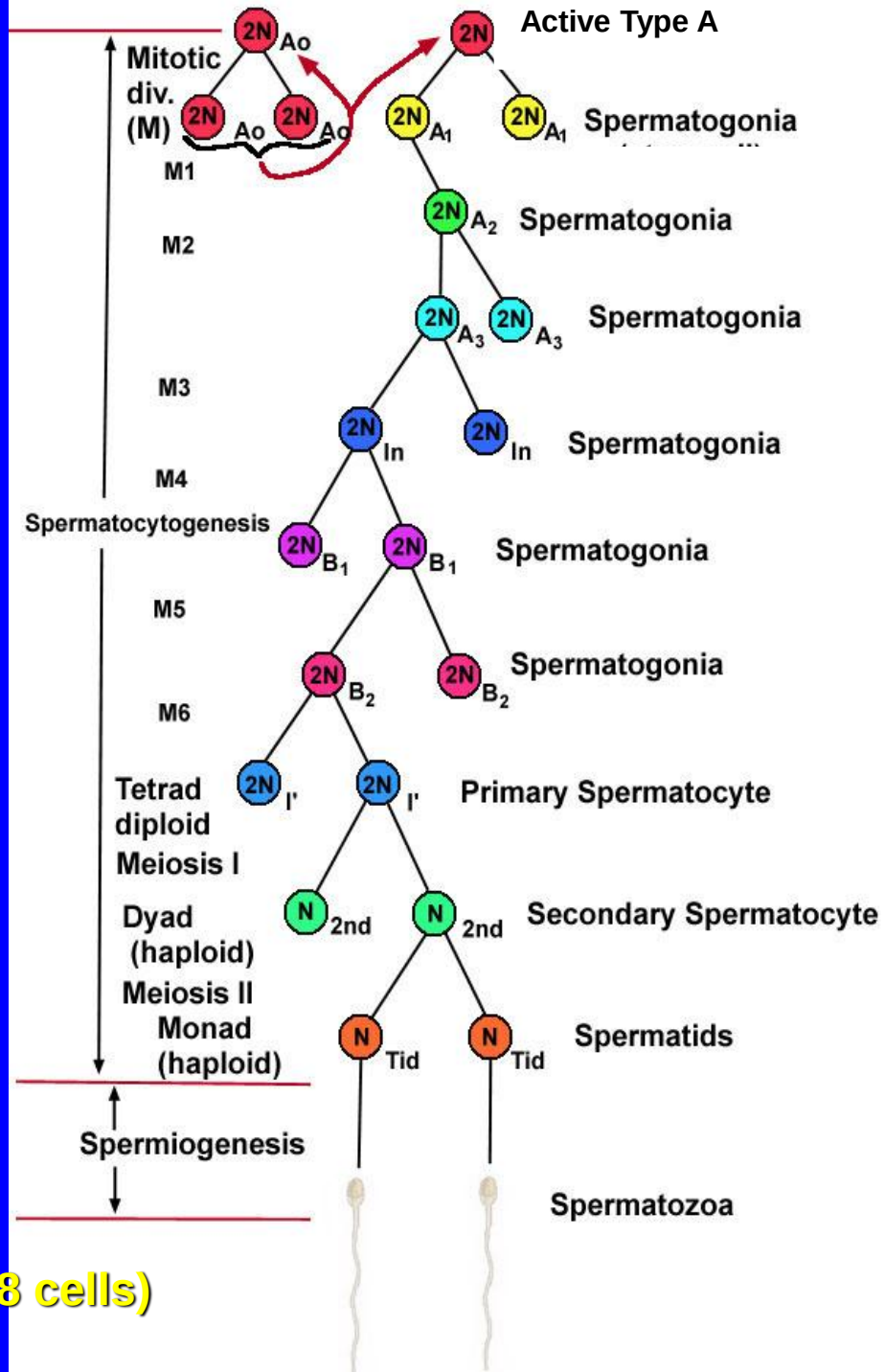
* Intermediate spermatogonium (In Spermatogonia)

Mitosis

* Type B spermatogonia

Mitosis

* PRIMARY SPERMATOCYTE (2N) (about 18 cells)



Q: Males continue to produce Spermatozoa throughout life. Comment?

1- Resting Type A_o spermatogonia stay at the basal surface and act as precursor = stem cells

2- Precursor Stem cell spermatogonia remain dormant for a time and then join a new proliferation of spermatogonia

3- The new wave of spermatogonial divisions does not wait for the previous generation of cells to complete spermatogenesis

The purpose of this phenomenon is to ensure a residual population of spermatogonia

4- The time required for one spermatogonium to divide and form spermatozoa requires about 4.5 to 5 times that time span between divisions of the stem cell spermatogonia

- Phases of Spermatogenesis

(A) Spermatocytogenesis:

1) Proliferative phase (Mitosis):

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2) Reduction phase (Meiosis):

Primary spermatocytes → Spermatids (N)

(B) Spermiogenesis:

Spermatids → Spermatozoaa

(B) Reduction phase (Meiotic divisions):

(Primary spermatocyte → Spermatids)

* Primary spermatocytes:

- largest germ cells of the germinal epithelium

- During passing the Sertoli cell barrier to reach the adluminal compartment, They exhibits:

1- duplication of DNA
= contain twice the DNA of a normal body cell
= pairing of homologuous chromosomes
("2 × 2N" = **Tetrad diploid**)

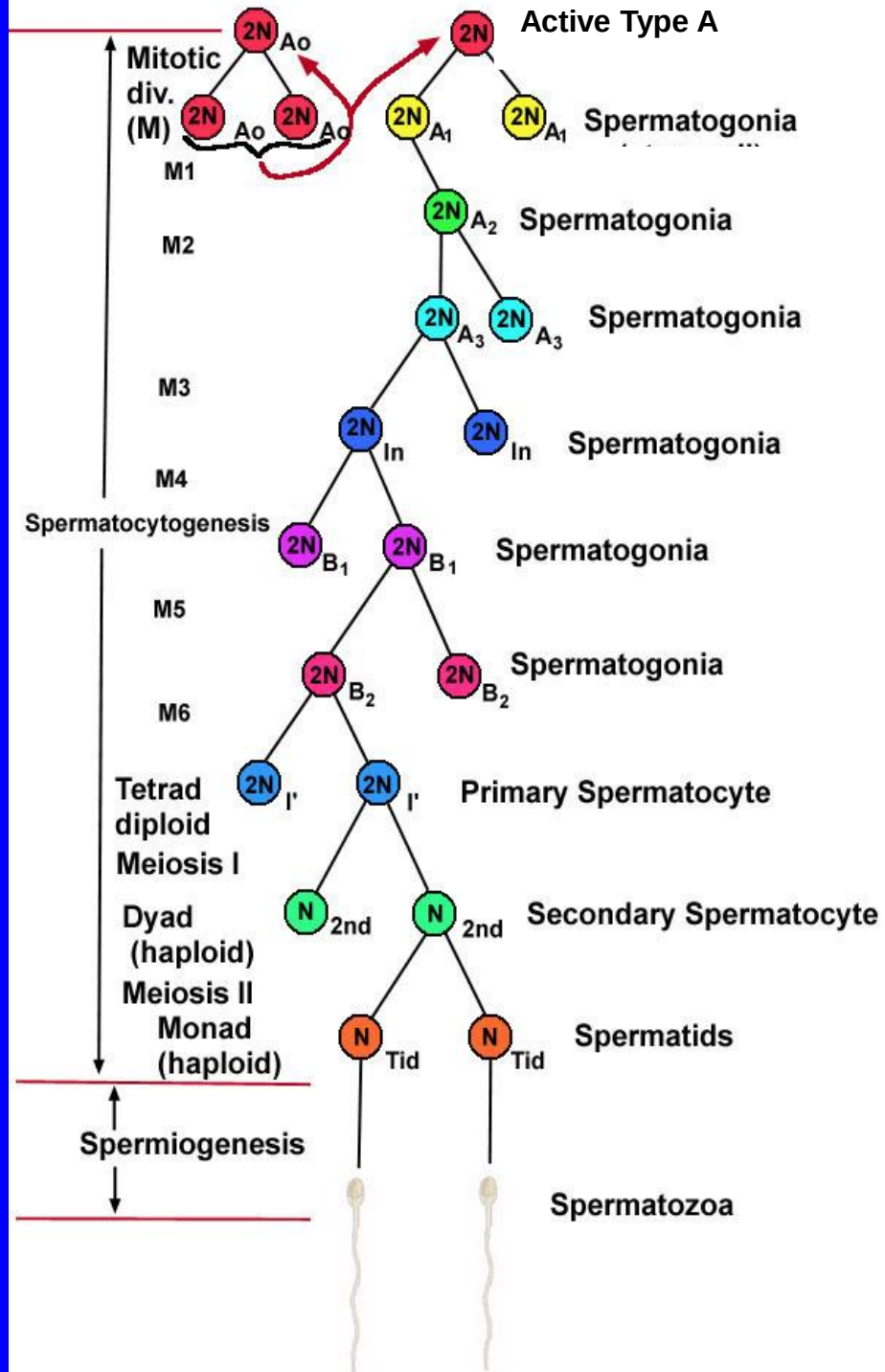
2- crossing over take place

- Meiosis I

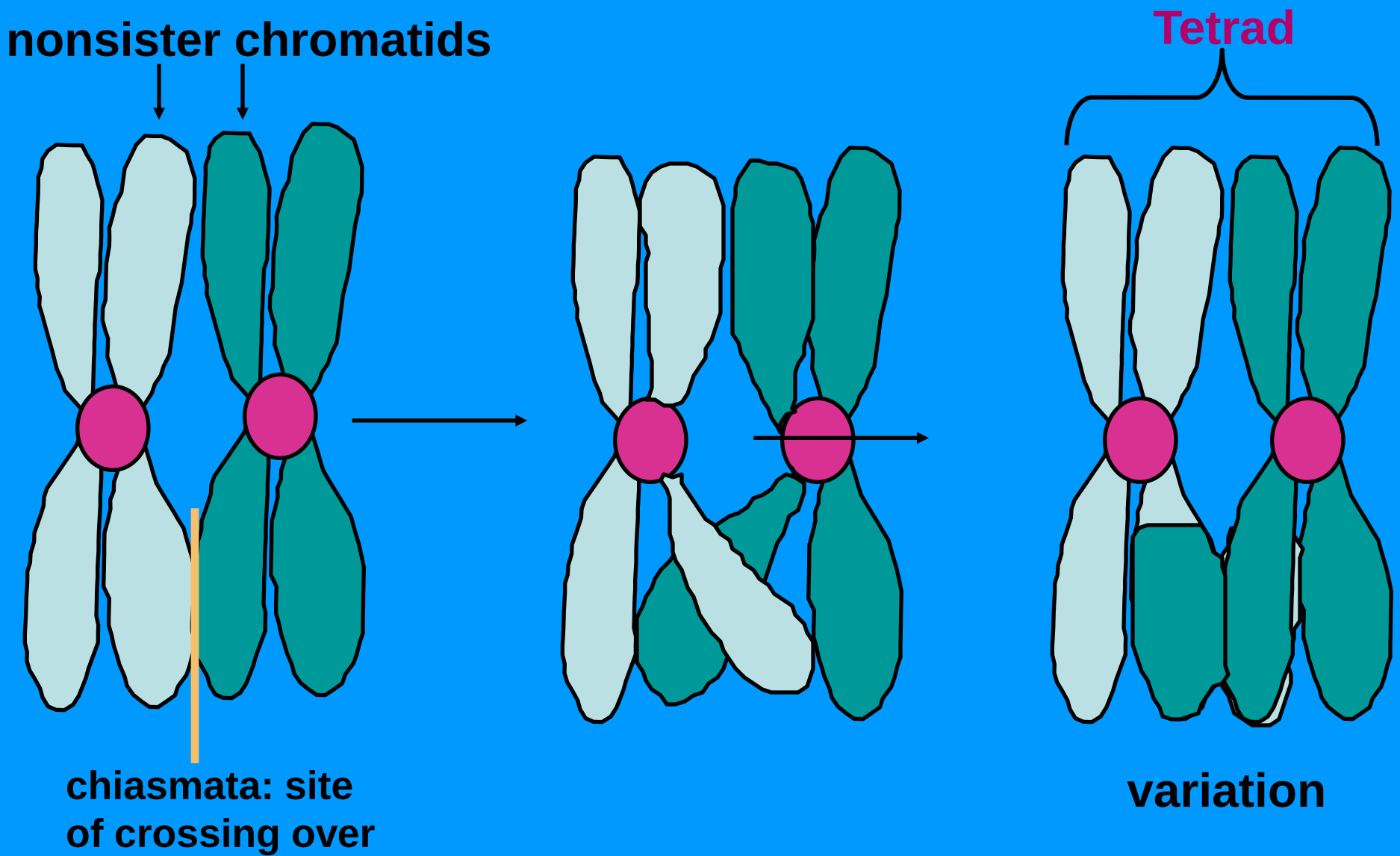
* Secondary spermatocytes ("1 × 2N" = Dyad haploid)

- Meiosis II

* Spermatids (N = Monad haploid).
(about 64 spermatids)



Crossing Over - variation



- Phases of Spermatogenesis?

(A) Spermatocytogenesis:

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2) Reduction phase (Meiosis):

Primary spermatocytes → Spermatids (N)

(B) Spermiogenesis:

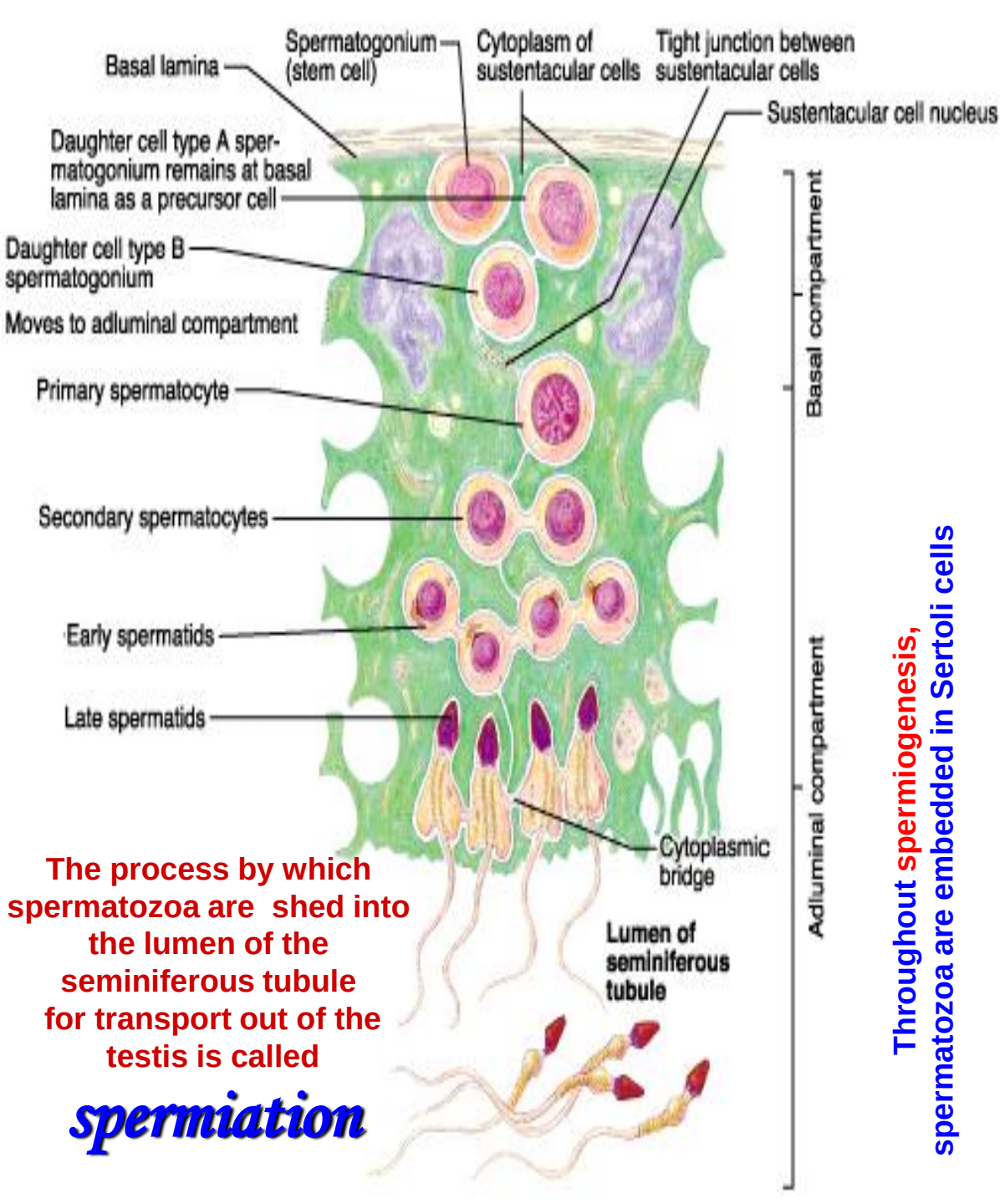
Spermatids → Spermatozoa

Spermiogenesis

Spermiogenesis

= Morphological conversion of round spermatid into spermatozoa without a division

= Nuclear and cytoplasmic changes in the spermatid that results in the *spermatozoa*



The process by which spermatozoa are shed into the lumen of the seminiferous tubule for transport out of the testis is called

spermiation

Throughout spermiogenesis, spermatozoa are embedded in Sertoli cells

What are the Phases of Spermiogenesis?

1- Golgi phase:

2- Cap phase:

3- Acrosomal phase:

4- Maturation phase:

(1) Golgi phase:

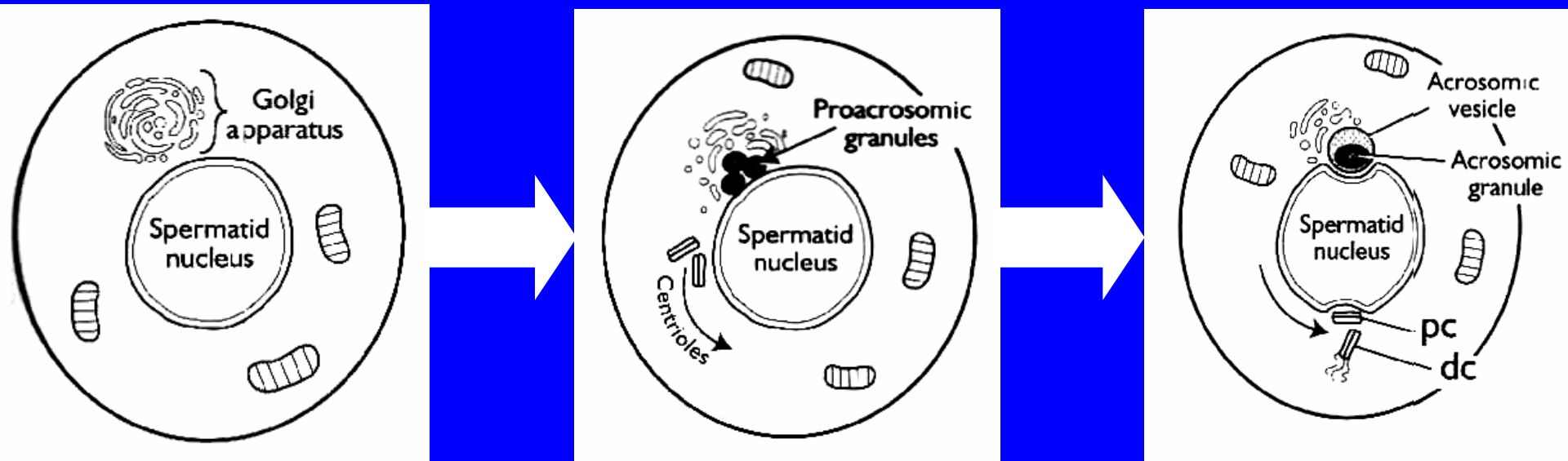
- Golgi apparatus (GA):

- main part → coallse to form single acrosomal vesicle

- remaining part → migrate to the posterior pole of the nucleus.

- Centrioles:

migrate to the posterior pole of the nucleus.



(2) Cap phase:

- Acrosomal vesicle:

spread over the nucleus till covering the nearly the 2/3 of the anterior pole⟶ forming **Acrosomal Cap**

- **Remaining part of GA:**

continues in migration to the posterior pole of the nucleus to form **Annulus**

- **Centrioles:**

a- Proximal centriole (PC):

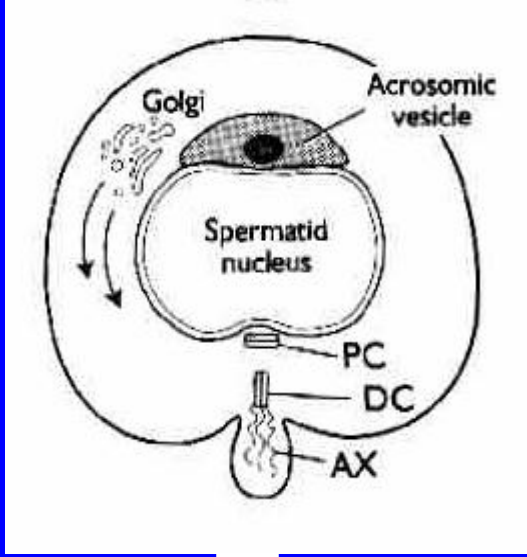
form implantation apparatus = base of attachment between the head and tail

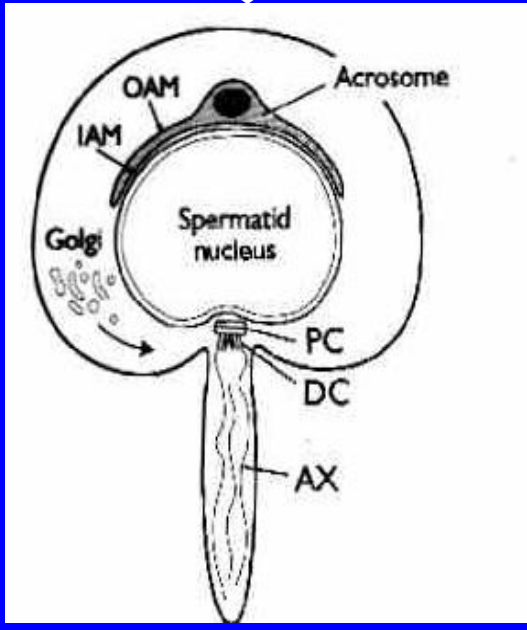
b- Distal centriole:

gives the flagellum (tail) that is composed of:

* axial filament (I pair of microtubules)

* Peripheral filament (9 pairs of microtubules)





AX = axoneme

(3) Acrosomal phase:

- **Nucleus:**

  - migrates from the center to the peripheray of the cell.

  - chromatin material condenses.

- **Acrosome:**

  - condenses and elongates to correspond the shape of the nucleus.

- **Annulus:**

  = ring-like cytoplasmic structure (consists mainly of GA)

  - formed near the proximal centriole then,

  - migrates to rest at the caudal end of the middle piece to form the space required for mitochondrial concentration around axial filament.

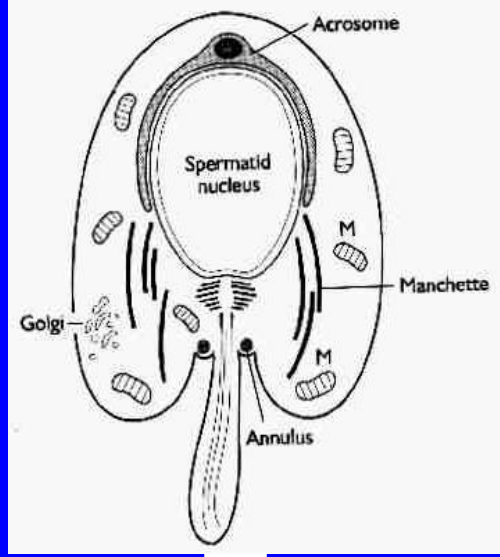
- **Cytoplasm:**

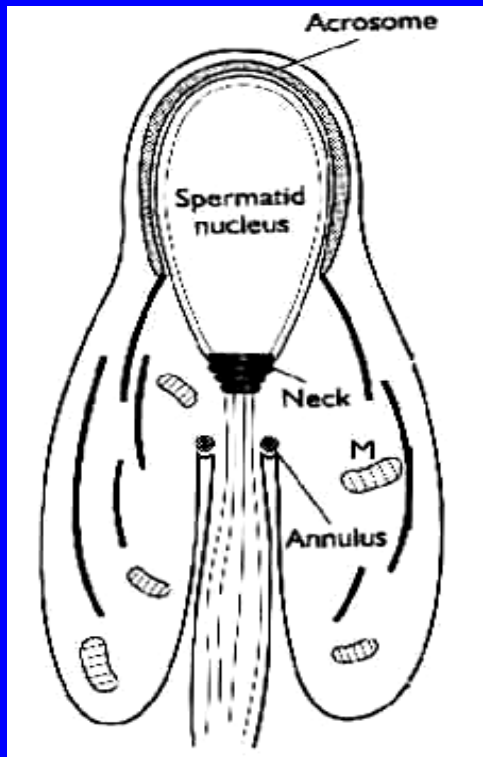
  - small part → casts off

  - bulk → elongates caudally forming caudal tube (Manchete).

- **Tail:**

  Protrudes posteriorly.





(4) Maturation phase:

- **Mitochondria:**

  - arrange themselves in the middle piece forming **Mitochondrial helix (ATP production).**

- **Cytoplasm:**

  - Main part at the neck → **cast off**

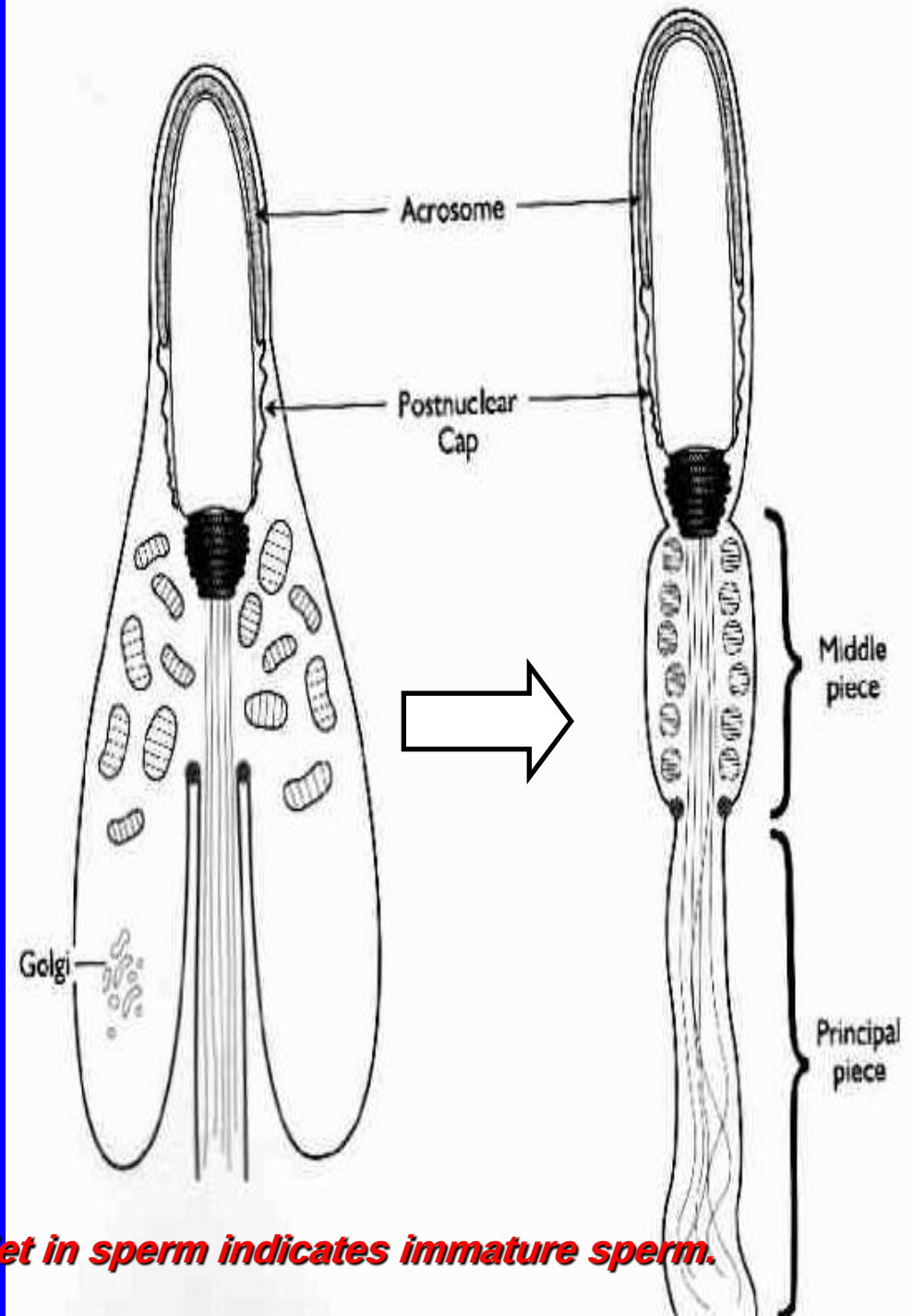
  - Small part → form residual protoplasmic droplet = **proximal cytoplasmic droplet = kinoplasmic droplet.**

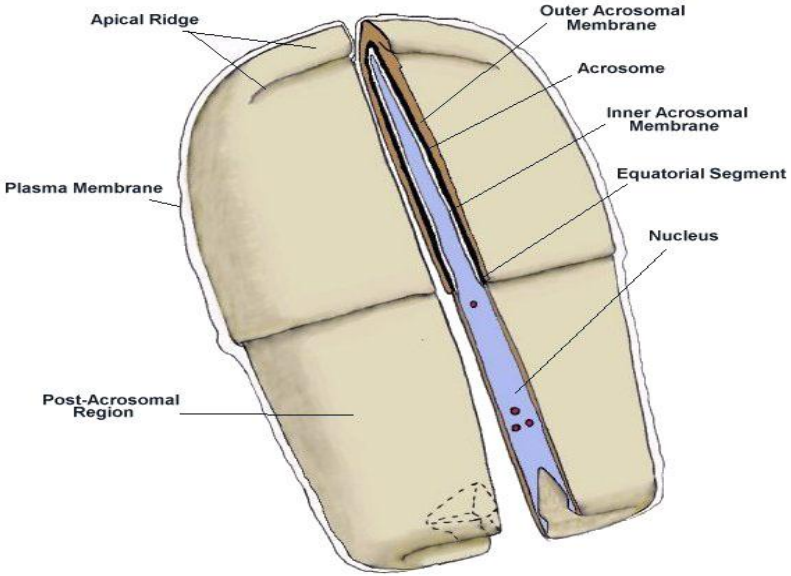
- With subsequent maturation:

  proximal cytoplasmic droplet migrates to rest at the end of the middle piece forming distal cytoplasmic droplet.

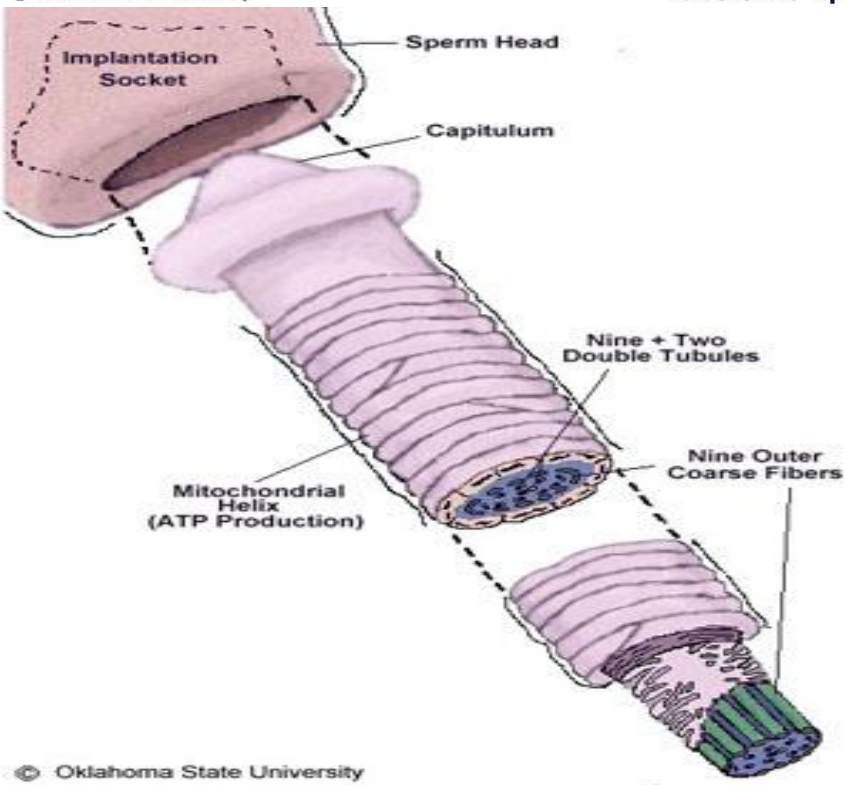
N.B:

Presence of proximal cytoplasmic droplet in sperm indicates immature sperm.

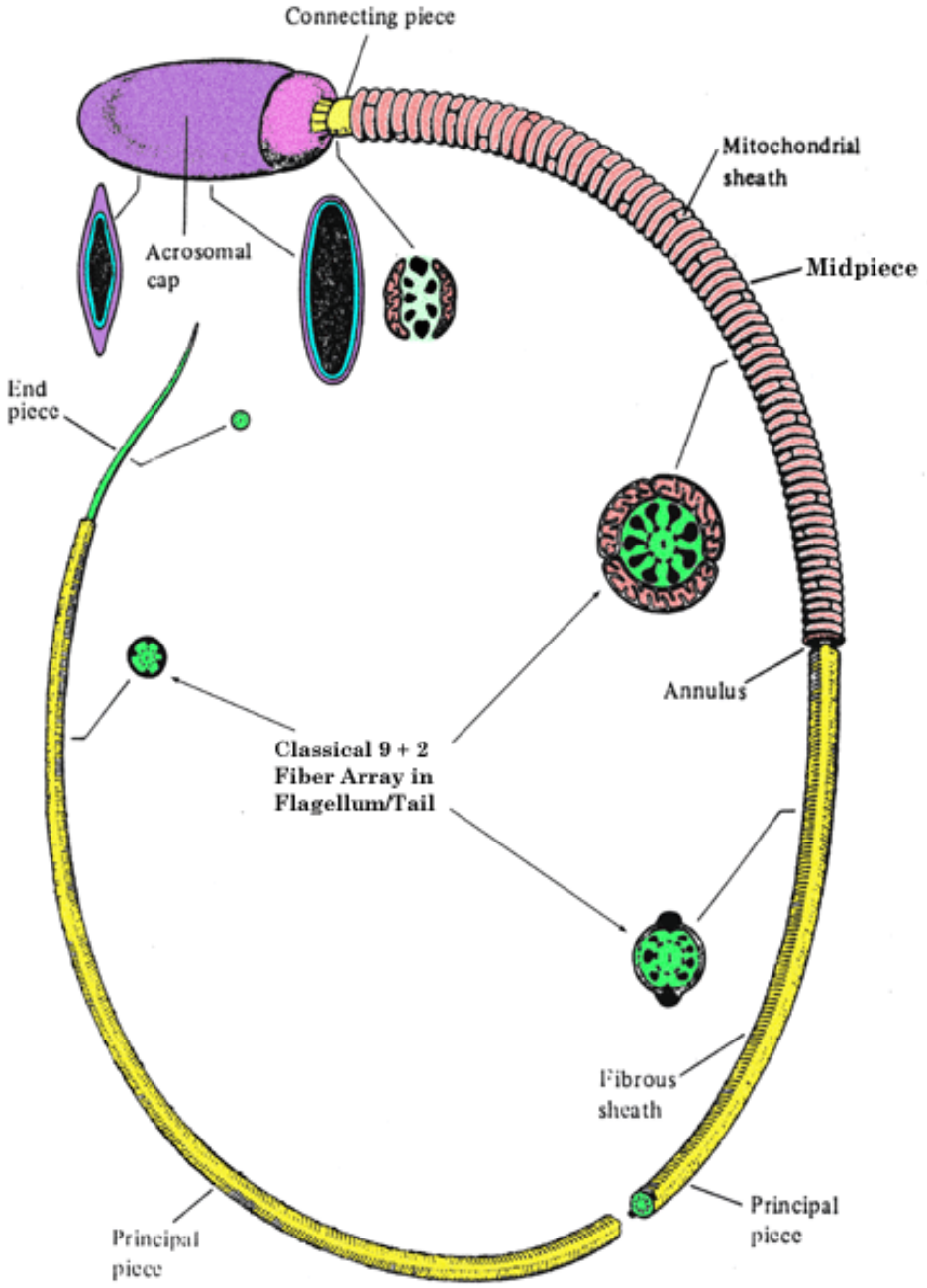




Randy Bradley



Internal Structure of the Mammalian Sperm



Modified from Fawcett, *Devel. Biol. 44*, 1975.

Sperm Maturation

Spermatozoa:

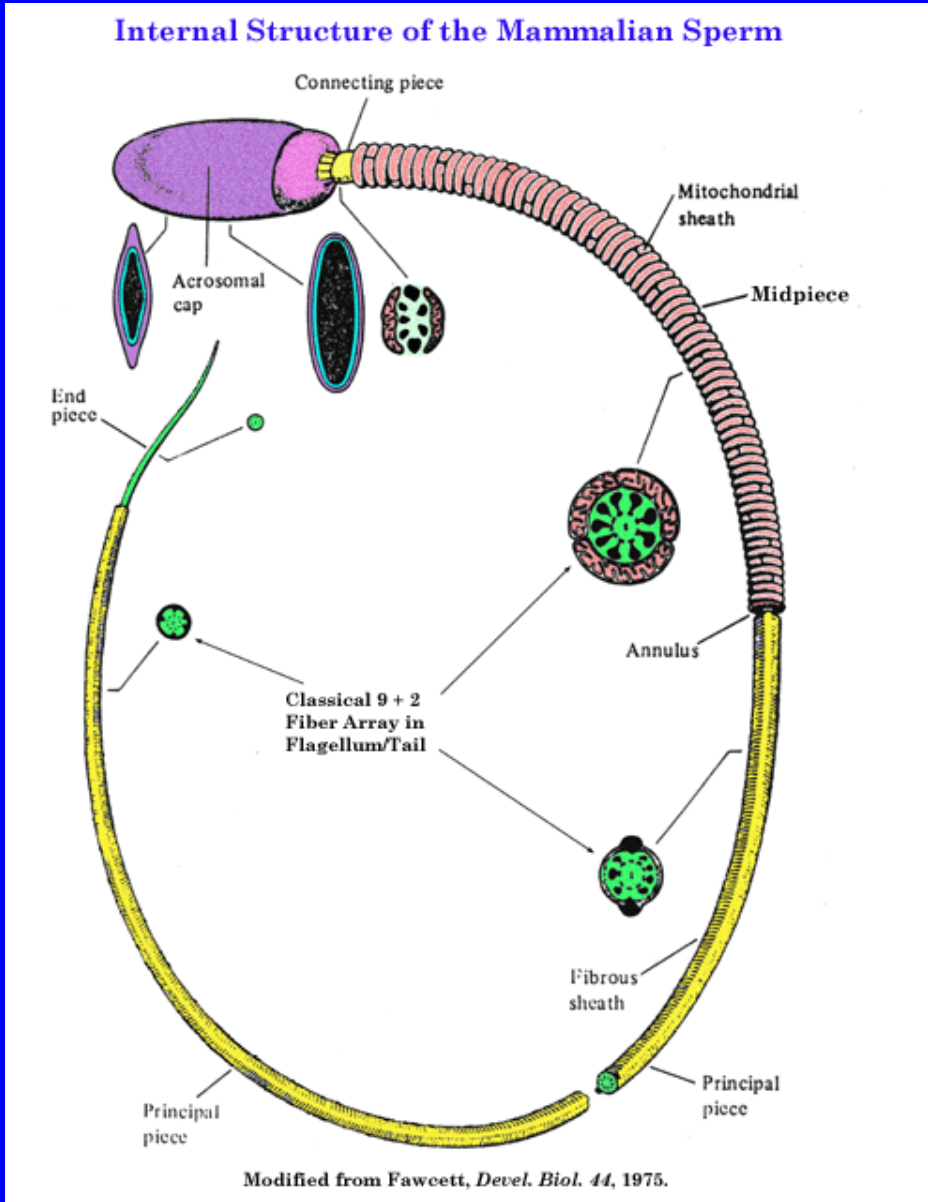
- Reach final shape in the testis

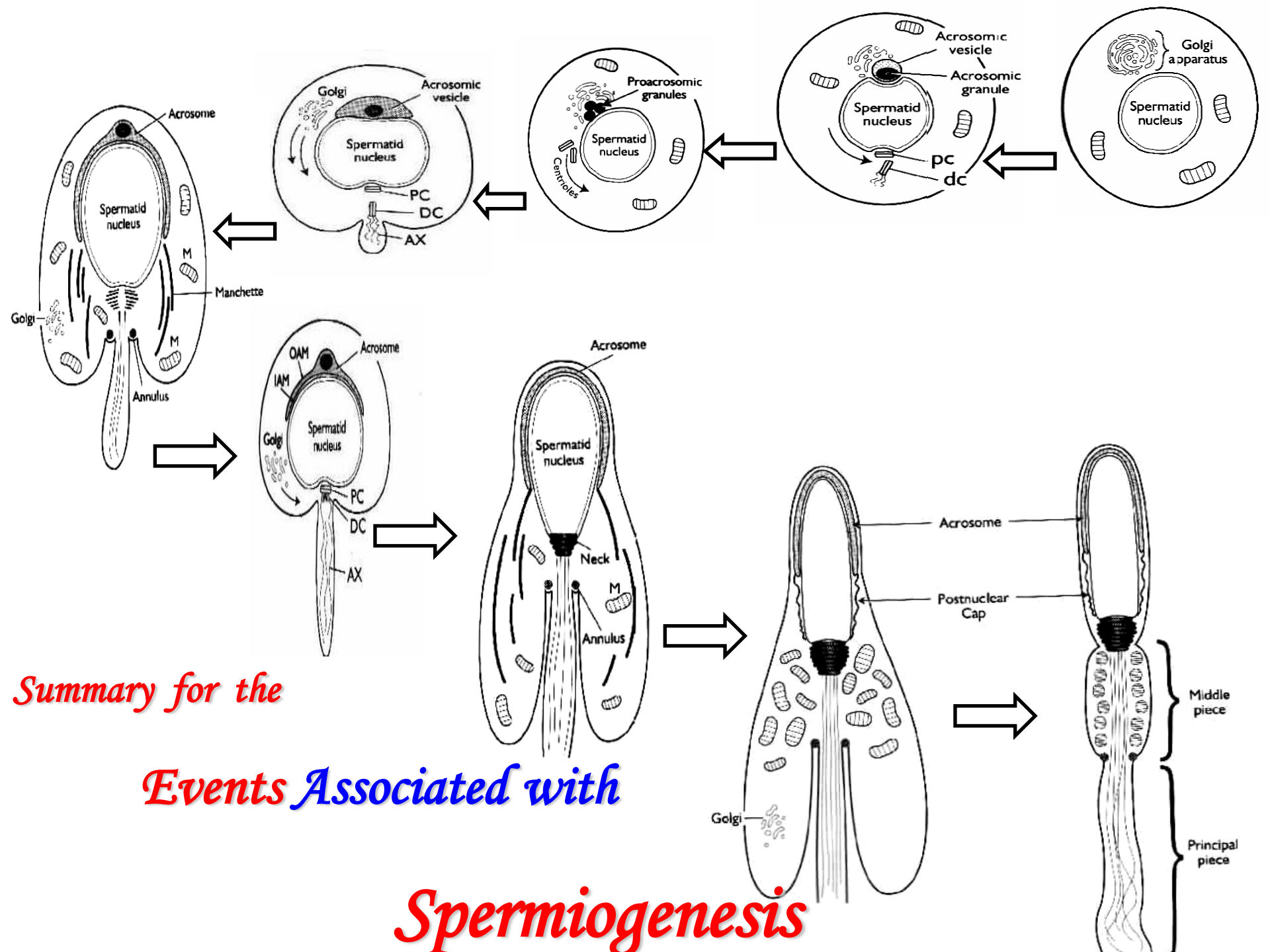
But,

- They gain functional maturity while passing through the epididymus & female reproductive tract.

- Activation of full motility, capacitation, in the vagina & cervix

- Final fertilizing ability after the acrosome reaction, usually near the egg.



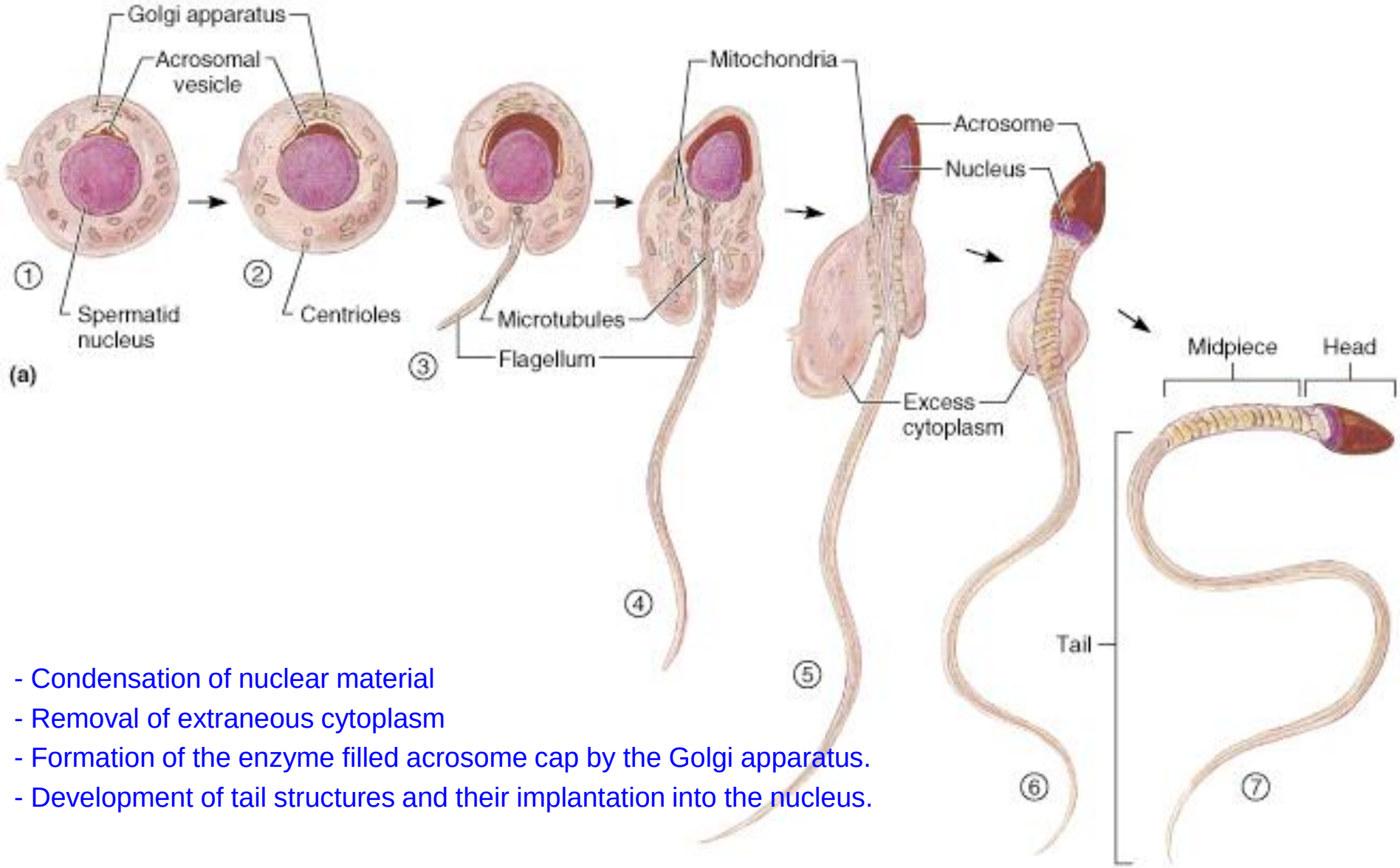


Summary for the

Events Associated with

Spermiogenesis

Summary for the Events Associated with Spermiogenesis



- Condensation of nuclear material
- Removal of extraneous cytoplasm
- Formation of the enzyme filled acrosome cap by the Golgi apparatus.
- Development of tail structures and their implantation into the nucleus.

Spermiation:

= expulsion of non motile sperms from Sertoli cells into the lumen of seminiferous tubules for transport out of the testis (i.e, into the epididymis, where maturation is completed).

* Associated with:

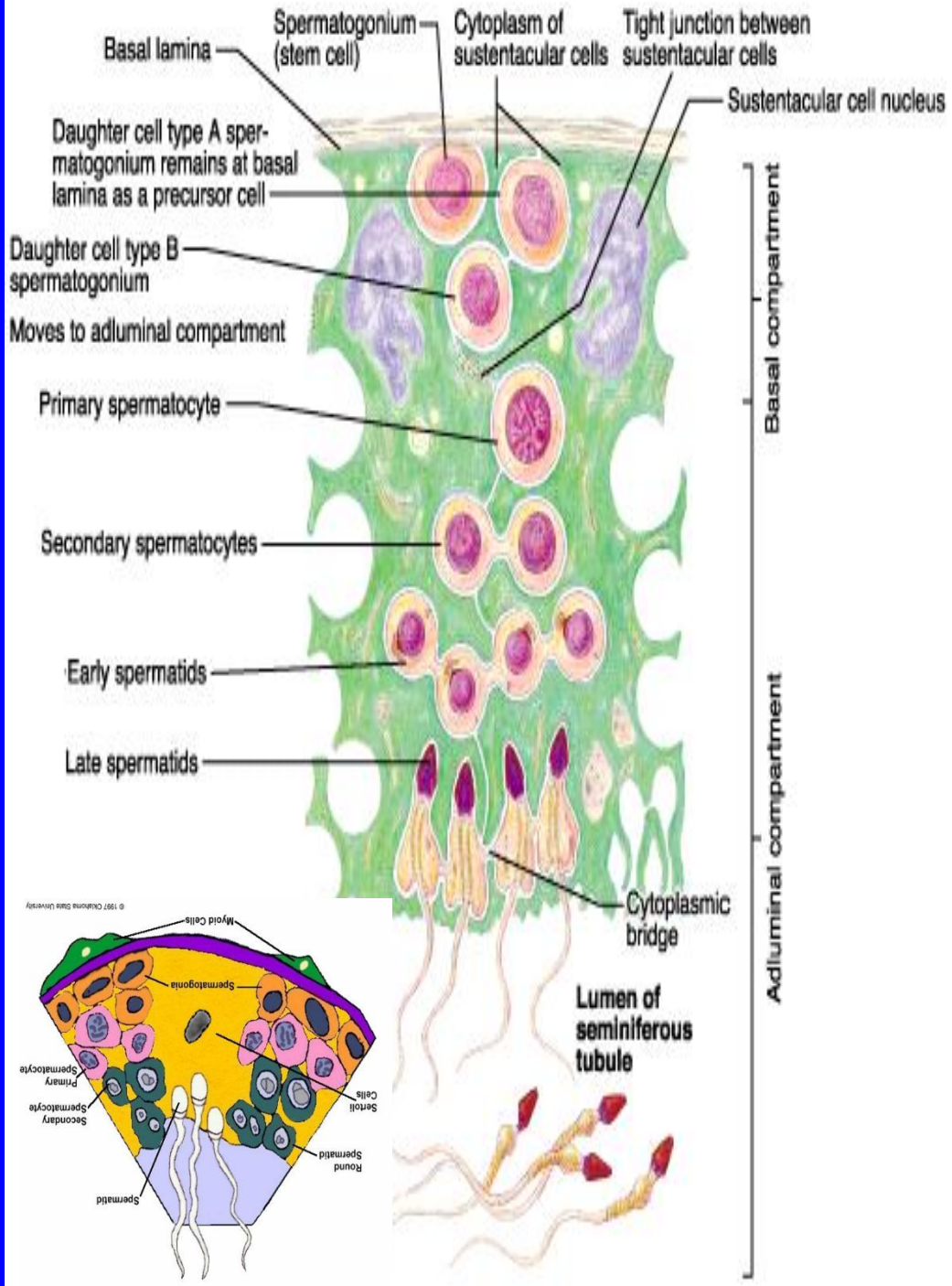
- **↑ cAMP content of sperm**
- **↑ forward motility protein (FMP) in sperm.**

** Helped by*:

(1) Proteolytic enzymes secreted by Sertoli cells.

(2) Contractile E of myoepithelial cells surrounding seminiferous tubules.

(3) relaxin secreted by prostate gland



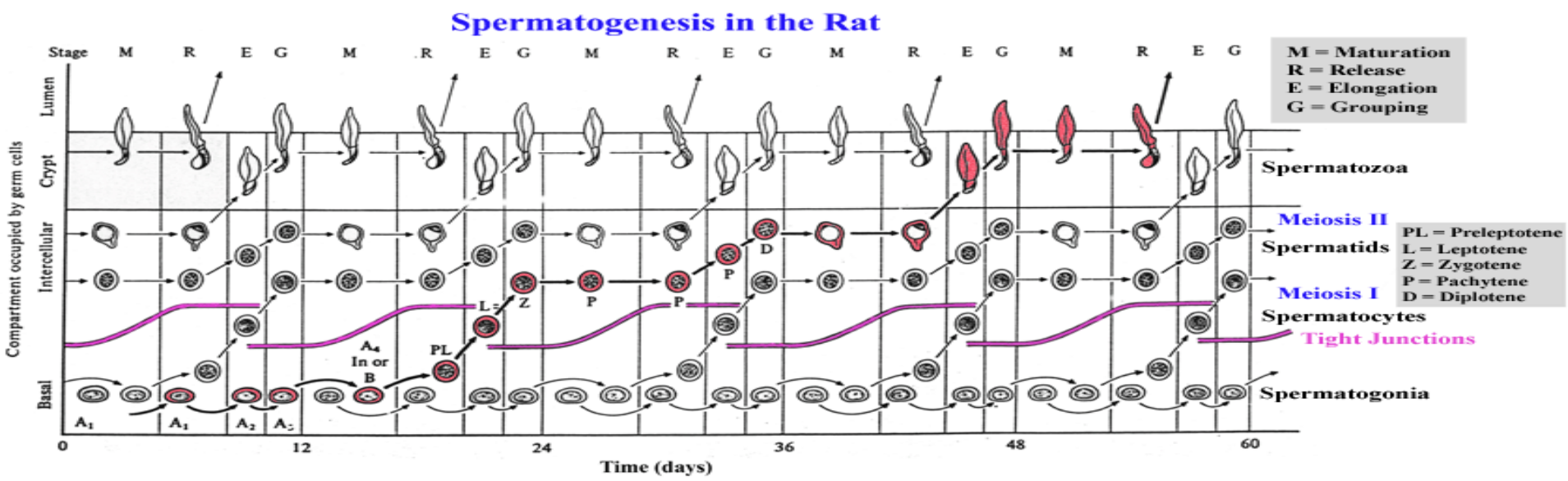
Spermatogenic cycle

= Series of changes:

- beginning with the division of stem cell and ending with spermiation
- occurring in a given area of seminferous tubule (epithelium).

= Period of time occupied by spermatogonium to be transformed into spermatozoa released into the lumen of seminiferous tubules

- Cycle consists of about 8 stages (A1, A2,…….Spermatid), **having definite relation to one another**. But, their number differs with species and investigator



Modified from Austin & Short, *Reproduction in Mammals, Book I: Germ Cells and Fertilization*, Cambridge University Press: Cambridge, UK, 1982.

Duration of spermatogenic cycle (days)

= Period of time occupied by spermatogonium to be transformed into spermatozoa released into the lumen of seminiferous tubules

	Spermatocytogenesis		Spermiogenesis	Total (Days)
	Proliferative phase	Reduction phase	Meosis	
Man	16	23	23	62
Bull	13	19	20	52
Ram	12	18	16	46
Boar	8	12	14	34
Rabbit				21
Cock				5-6

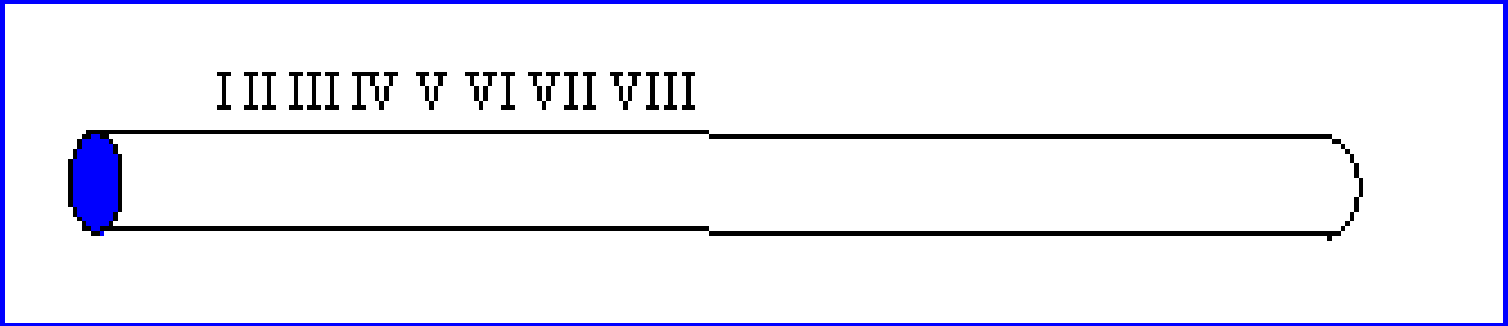
- Length of the whole cycle is species-specific.
- Cycle consists of the following phases:
  - (a) period of multiplication (Proliferative phase)
  - (b) period of meiosis (Reduction phase)
  - (c) period of metamorphosis (Spermiogenesis)
- *Physiological significance:*

  helps in the assessment of the several factors, which regulate the process of spermatogenesis and its rate.

Spermatogenic wave

= Succession of stages along the length of seminiferous tubules

= sequence of successive stage of spermatogenic cycle along the length of seminiferous tubule.



- Bull: about 10 mm.
- Man: not well defined

What is the overall result of spermatogenesis?

1- Cell proliferation
   - More cells are produced than originally present
   - Each spermatogonia may produce up to 256 spermatozoa per cycle

2- Maintenance of a reserve germ cell population
   - Production of new spermatogonia is faster than maturation of spermatozoa

3- Haploid gametes are produced

4- Genetic variability is introduced
   - Crossing-over during Prophase I of meiosis

5- Spermatids mature into spermatozoa

Functions of the testis:

1- Germinal epithelium:

Exocrine function = Production of sperms

(Spermatogenesis)

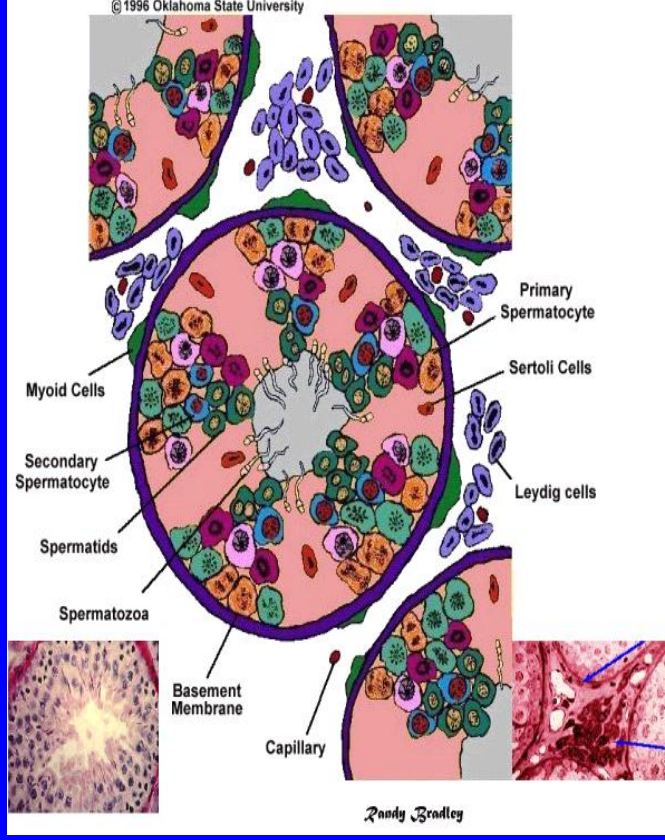
2- Sustentacular (Sertoli) cells?

Promote sperm development.

3- Interstitial (Leydig) cells?

Endocrine function = Secrete testosterone

4- Transport sperm out of the testis?



Sustentacular (Sertoli) cells

Functions of Sustentacular (Sertoli) cells:

1- Nurse cell:

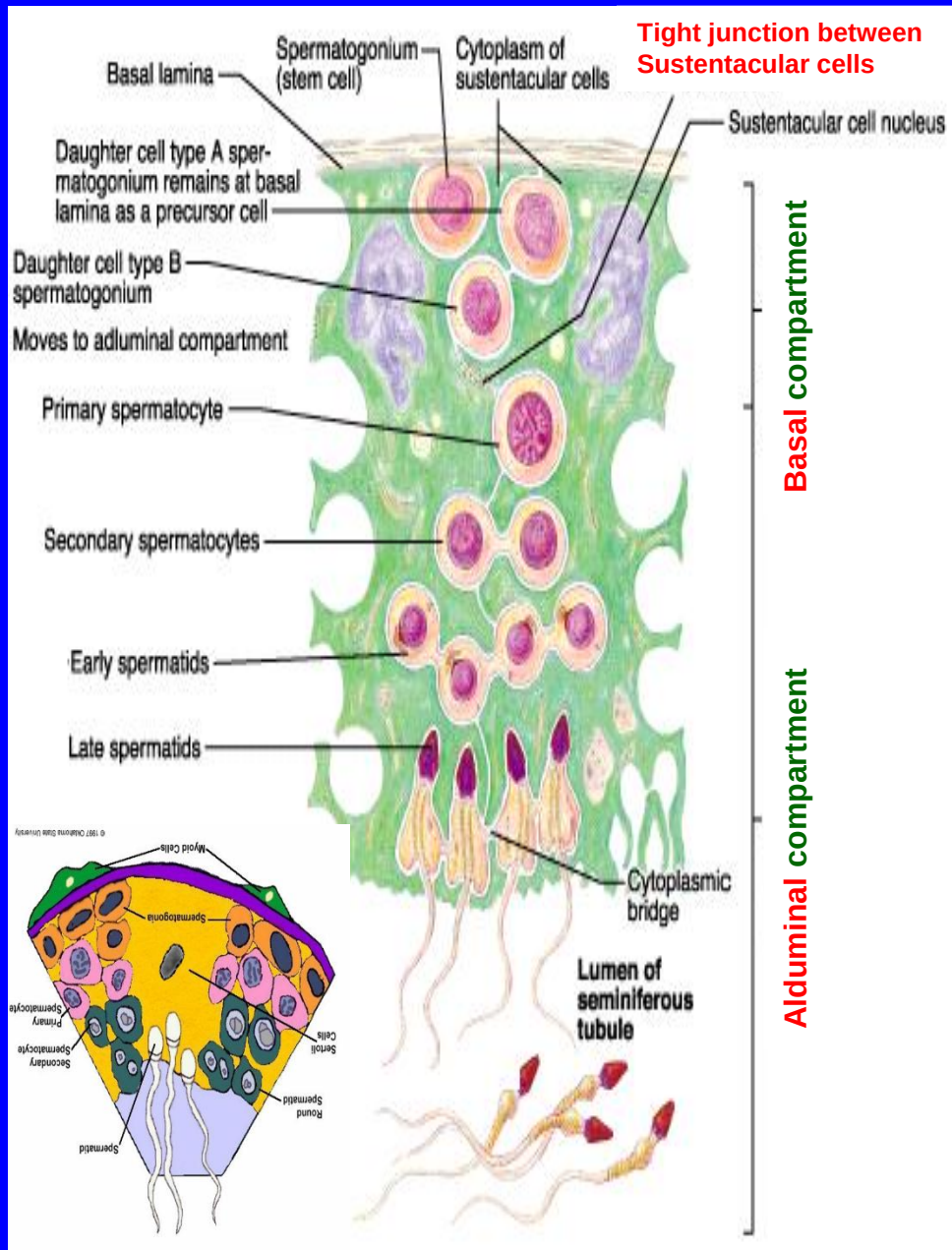
Cytoplasm forms numerous shelves-like processes, which provide:

a- Support for germ cells

b- Environment for germ cells to develop and mature

2- Phagocytosis of degenerated germ cells:

Therefore, it is not uncommon to find lysosomes, residual bodies, and even sperm fragments in the cytoplasm of Sertoli cells.



Functions of Sustentacular (Sertoli) cells:

3- Compartmentation of seminiferous tubules:

The lateral borders of two adjacent Sertoli cells are specialized to form **tight junctions**, often called

Blood-testis barrier,

Which

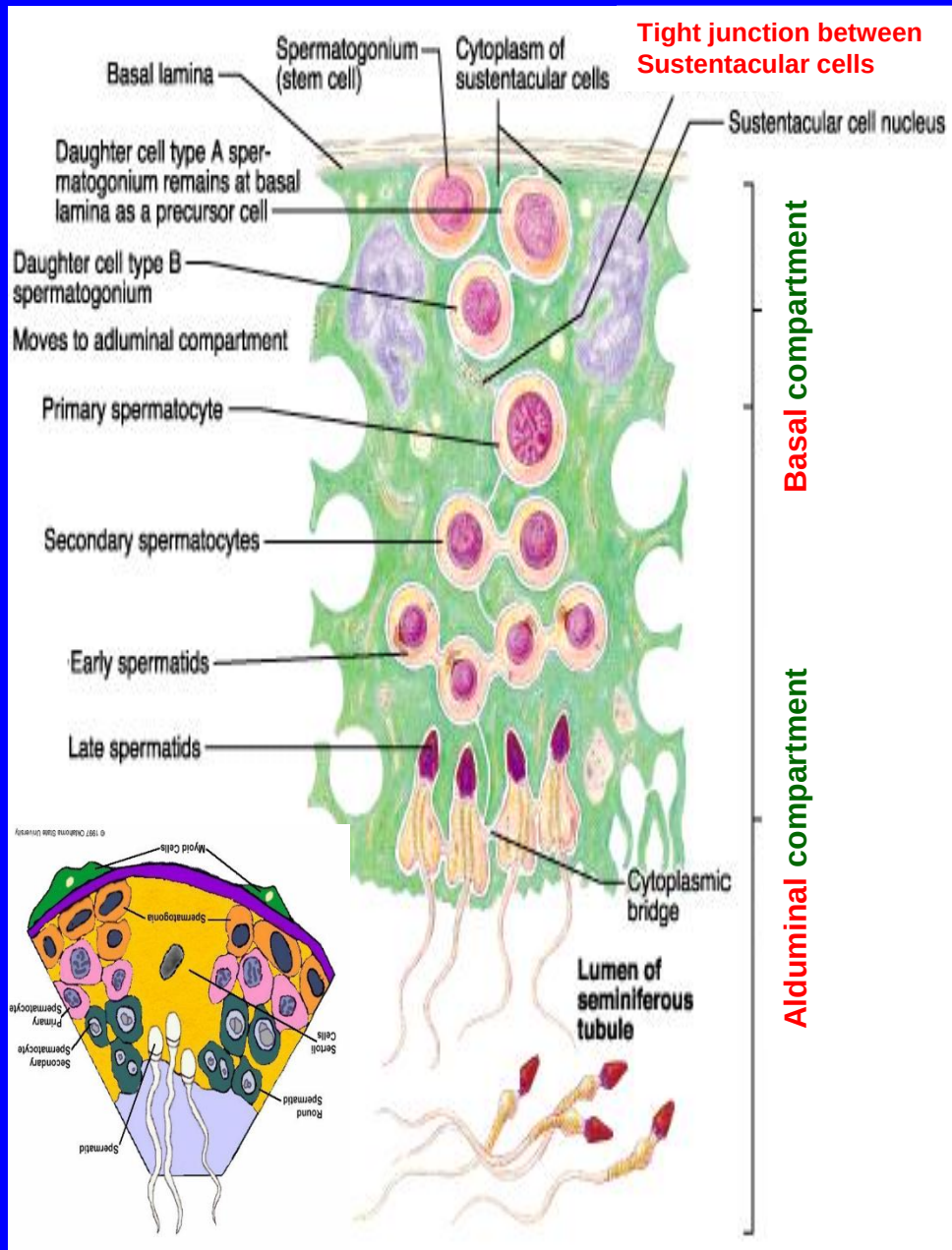
divides the seminiferous epithelium into two compartments:

a) basal compartment:

= Space in which spermatogonia develop to primary spermatocyte

b) Alduminal compartment:

= Space in which primary spermatocytes develop to spermatozoa



Functions of Sustentacular (Sertoli) cells:

Physiological significance of blood-testis barrier:

Nutritive and protective function?

1- Cells of the basal compartment

are diploid (2N)

↓

not attacked by the immune system

↓

get their nutrients directly from the blood vessels lying in contact with the basal lamina.

2- Cells of the adluminal compartment:

are haploid (N)

↓

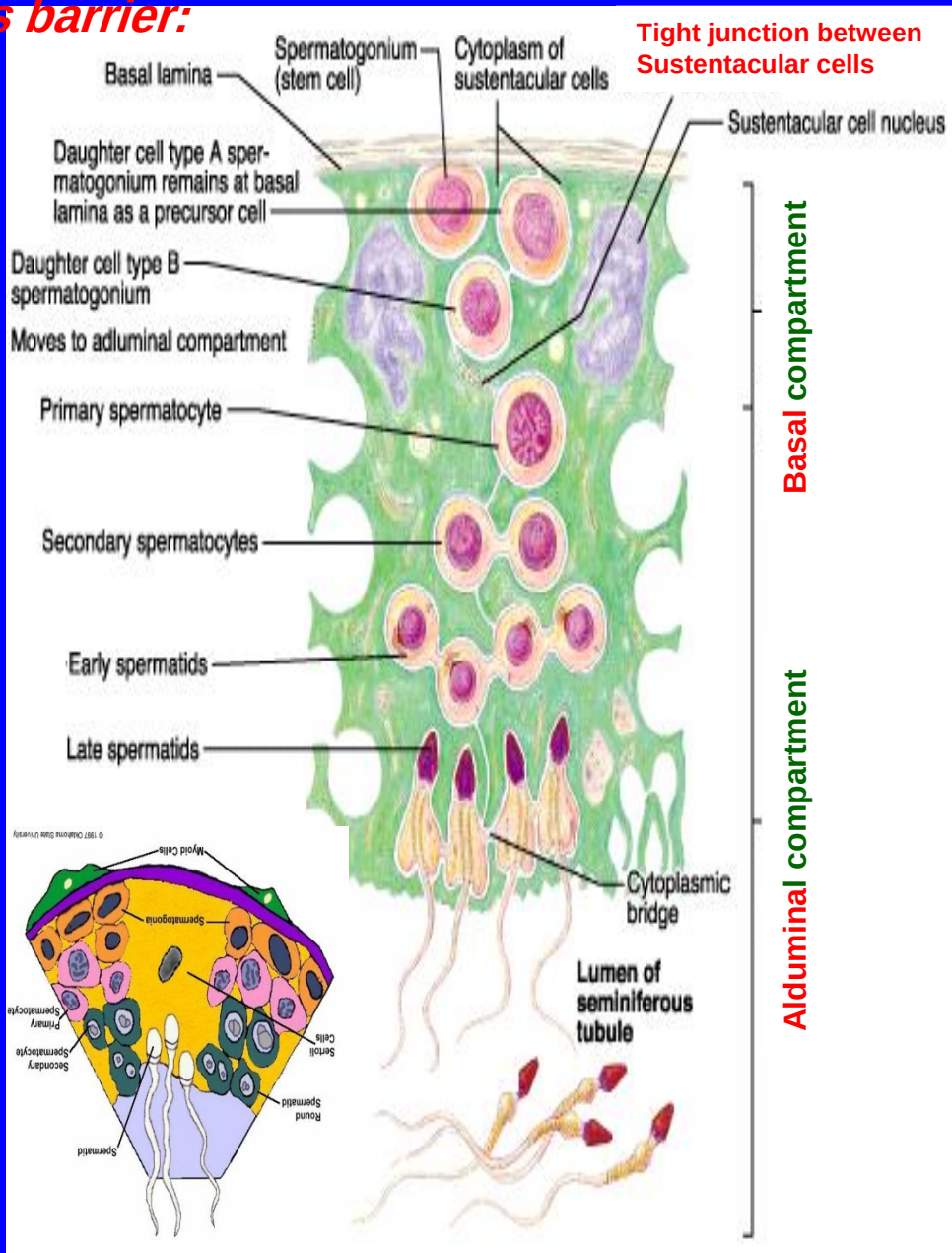
considered non-self by the immune system.

↓

A male will produce antibodies that attack his own sperm, if the sperm is exposed to circulation (lymphocyte).

↓

So, they depend upon Sertoli cells for their nutritional needs (Sertoli cells pump nutrients from peritubular capillaries into tubular lumen



Functions of Sustentacular (Sertoli) cells:

4- Exocrine function:

- Secrete androgen binding protein (ABP)

essential for transportation of Testosterone into the lumen of seminiferous tubules

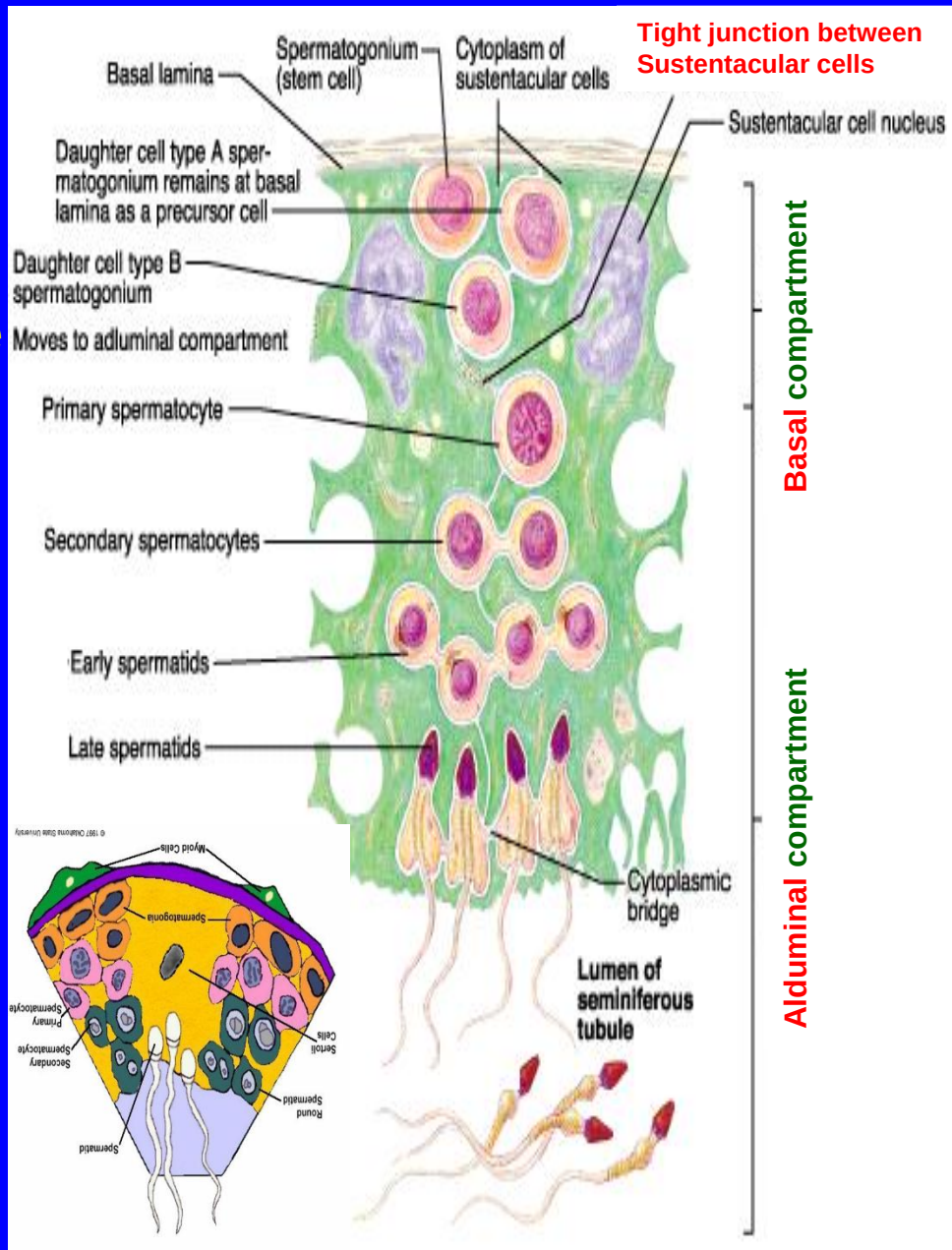
↓

Maintain a high intratubular concentration Testosterone

↓

1- suppresses antibodies (produced by lymphocytes which slip blood testicular barrier) that attack own sperm.

2- necessary for all stages of spermatogenesis



Functions of Sustentacular (Sertoli) cells:

5- Endocrine function:

- Secrete

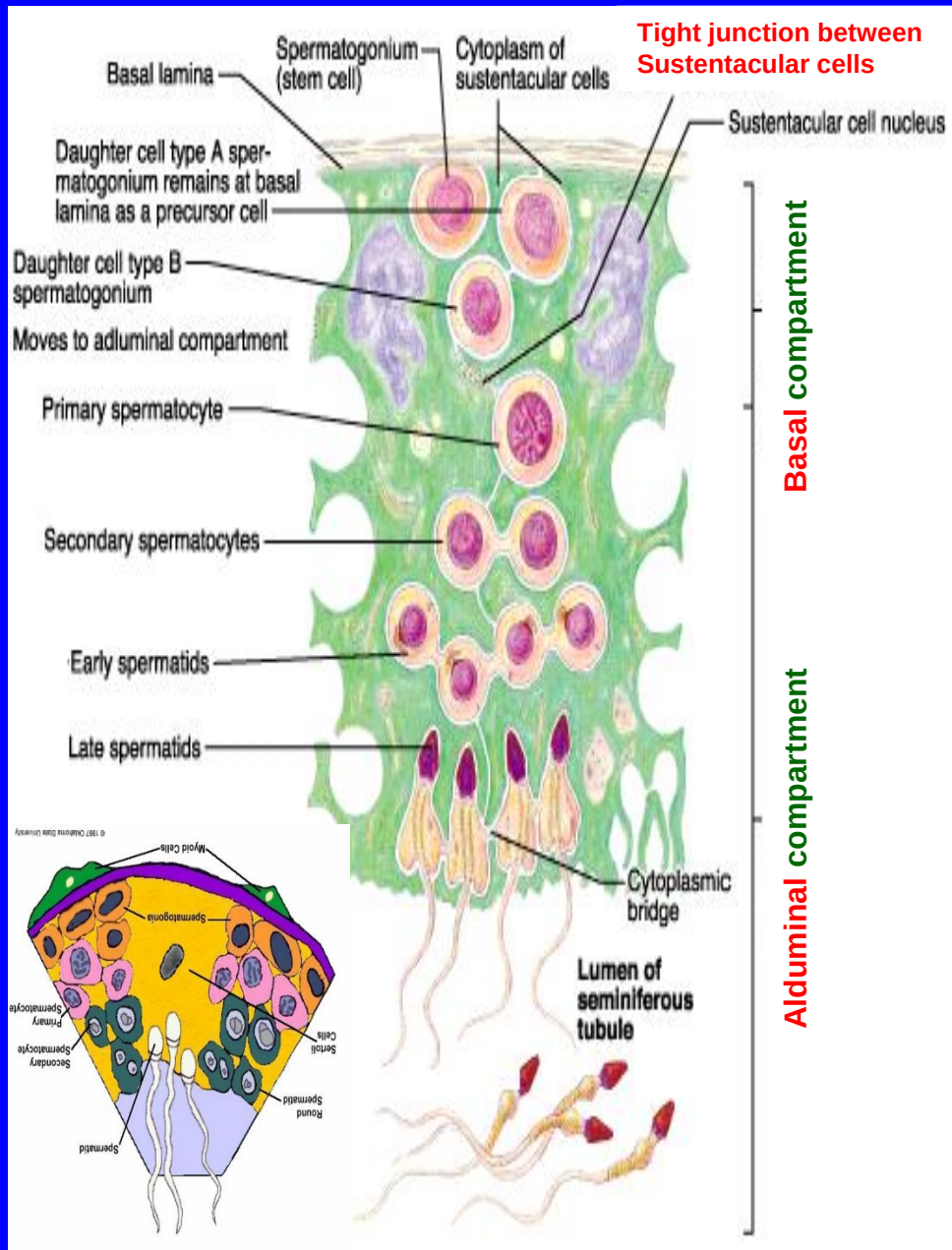
A) Estrogen → may be secreted in large quantities by Sertoli cell tumour, which is common in dog causing feminization.

B) Inhibin → **Suppresses pituitary GnH synthesis and release (particularly FSH)**

6- Regulate spermatogenic cycle:

= Organization of the delivery of mature spermatids into the tubular lumen

(spermiation).



Interstitial (Leydig) cells
(Endocrine cell)

Function of Leydig cells:

Source of testosterone.

N.B:

The number of Leydig cells is species-dependent and is directly related to the amount of testosterone secretion . Consequently, the size of accessory sex gland and semen volume are also related.

Species	Leydig cell number	Testosterone secretion	Size of Accessory sex glands	Semen volume
Pig	Numerous	++++	++++	200-300ml
Stallion	Numerous	++++	++++	50-150ml
Dog	abundant	++	++	7-15ml
Ruminant	Few	+	+	1-3ml
Man	Few	+	+	1-3ml
Cock	Few	+	+	1ml

Functions of Testosterone:

Testosterone is responsible for:

1- Secondary sex characters in males:

= features that develop at puberty to further distinguish the sexes and attract a mate e.g., pubic, axillary & facial hair, scent glands, body morphology and low-pitched voice in males

2- Differentiation of genital organs → *Embryonal stage*

3- Development of genital organs (seminiferous tubules, epididymis, accessory sex glands) → *Adolescence*

4- Maintenance of structure and activity of genital organs → *Sexually mature animals*

- Libido (male sex behavior)
- Spermatogenesis

5- *Suppression of immune response within the testis:*

- Testosterone level within the lumen of seminiefrous tubules is much higher than circulation (due to androgen binding protein "ABP).
- Such high level of T suppresses antibodiy (produced by lymphocytes which slip blood-testicular barrier) that attack own sperm.

7- General metabolic activity.

Effects of Cryptorchidism on Leydig Cells

Although, cryptorchid animals (bilateral) fail to produce sperm,

Leydig cells remain *Active*.

Hence, cryptorchid animals can maintain

Libido

&

Secondary sex characters.

What is the effect of castration on Accessory Glands?

Activities of the accessory glands are controlled by testosterone.

Therefore,

Castration (removal of testicles) leads to atrophy of these glands.

Factors/Forces Responsible For Transport of Spermatozoa Along the Length of Excurrent Ducts

A. From seminiferous tubules to rete testis to ductuli efferentes.

1. Testicular fluid
2. Contraction of smooth muscles surrounding the seminiferous tubules.
3. Contraction of testicular capsule.

B. From ductuli effernetes to caput epididymidis

1. Movement of cilia lining the epithelium of ductuli efferentes
2. Contraction of smooth muscles surrounding the D. E.

C. From caput epididymidis to cauda epididymidis

1. Contraction of epididymal smooth muscles.
2. Sperm are stored in the cauda epididymidis of the bull for 40-60 days without any loss of fertilizing ability.

Factors affecting

TESTICULAR FUNCTION

Factors affecting testicular function:

1- Hormones:

- Hypothalamo-hypophyseal-testicular relationship:
- Testicle-thyroid relationship:
- Testicle-adrenal relationship:

2- Environment:

- Effect of Season
- Effect of Temperature
- Effect of Light

3- Nutrition:

- Energy
- Vitamins
- Protein defeciency
- Minerals

4- Psychic factors:

5- Noxious agents:

- Radiation
- Pathological conditions

Hormone	Source	Target	Action
1- FSH	Ant. Pit.	Sertoli cells	1- Promotes its nursing function till complete during spermatogenesis. 2- Stimulates secretion of ABP→ bind testosterone→ maintain high local level inside seminiferous tubules→ essential for spermatogenesis. 3- Stimulate secretion of inhibin hormone
		Leydig cells	Sensitize Leydig cells for LH→ ↑ testosterone sec.
		Germ cells	- Enhance mitotic divisions of spermatogonium into type A - Together with Androgen promote all stages of spermatogenesis
2- LH (ICSH)	Ant. Pit.	Leydig cells	- Stimulate secretion of testosterone.
3- Testosterone	Leydig cells	Germ cells	- Local high level is essential for all stages of spermatogenesis - Suppress GnRH and GnH. (-ve feedback)
4- Inhibin:	Sertoli cells	Ant pituitary	Suppresses FSH synthesis and release (-ve feedback)
5- Activin:	Sertoli cells	Ant pituitary	Stimulates FSH secretion (+ve feedback)
6- Thyroid hormones:	Thyroid gl.	All body cells	Normal testicular function.
7- STH (Growth hormone)	Ant. Pit	All body cells	Metabolic hormone.

N.B:

- Testosterone alone can maintain spermatogenesis. However, the yield of spermatozoa is increased if FSH is present

Hhpothalamo-hypophyseal-testicular relationship:

- Pre-puberty (Before puberty):

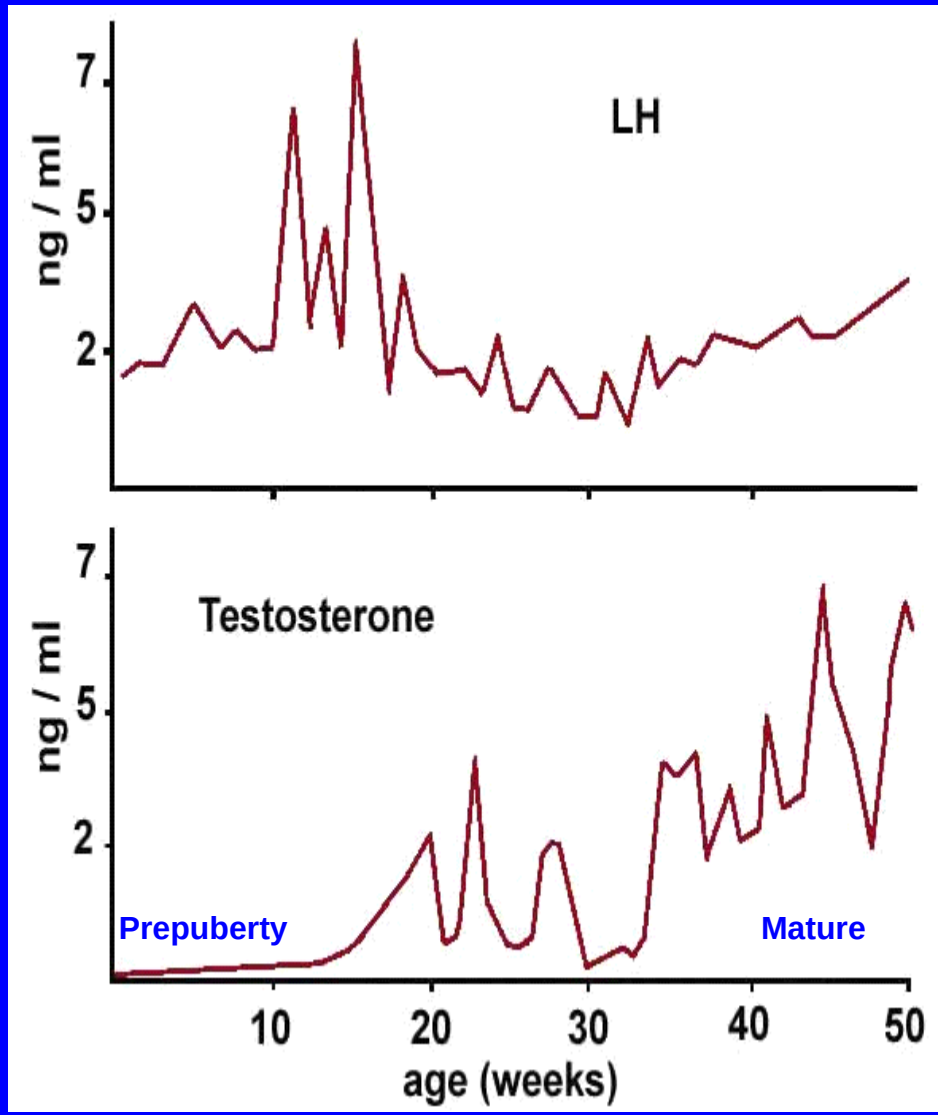
Hypothalamus and pituitary gland are highly sensitive to feedback inhibition induced by low level of sex steroids

Evidence:

Implantation of small quantity of crytslline testosterone into median eminence of hypothalamus→ retard development of testis and accessory glands.

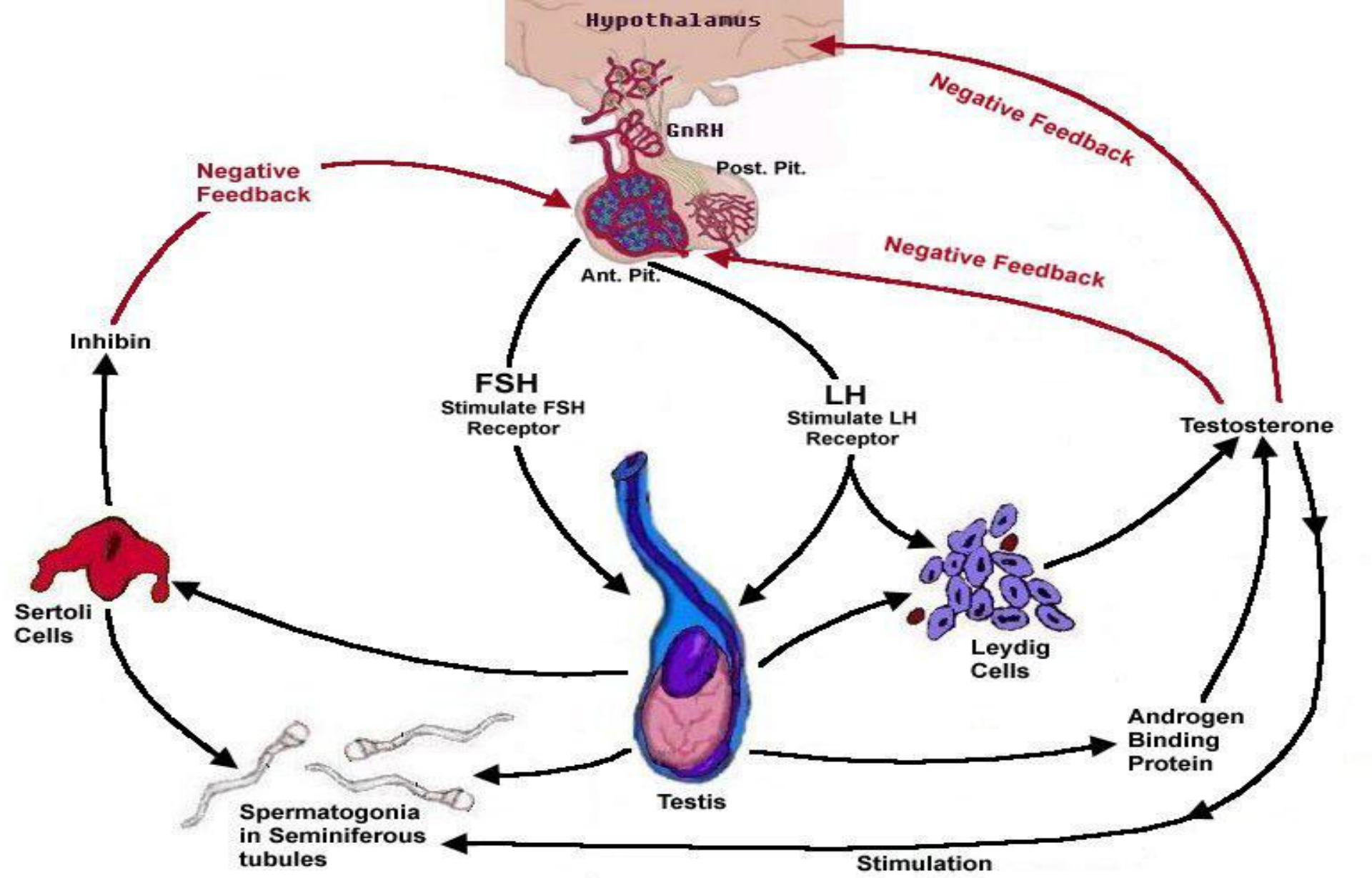
- After puberty (mature animal):

Hypothalamus and pituitary gland become less sensitive to feedback inhibition induced by sex steroids



Gonadostat theory of puberty onset:

"A gradual decrease in the inhibitory feedback effects of gonadal steroids during advancing sexual maturation"



Hhpothalamo-hypophyseal-testicular relationship in mature animal

Role of Neurotransmitters in the control of testicular function :

Recent studies indicate that there is:

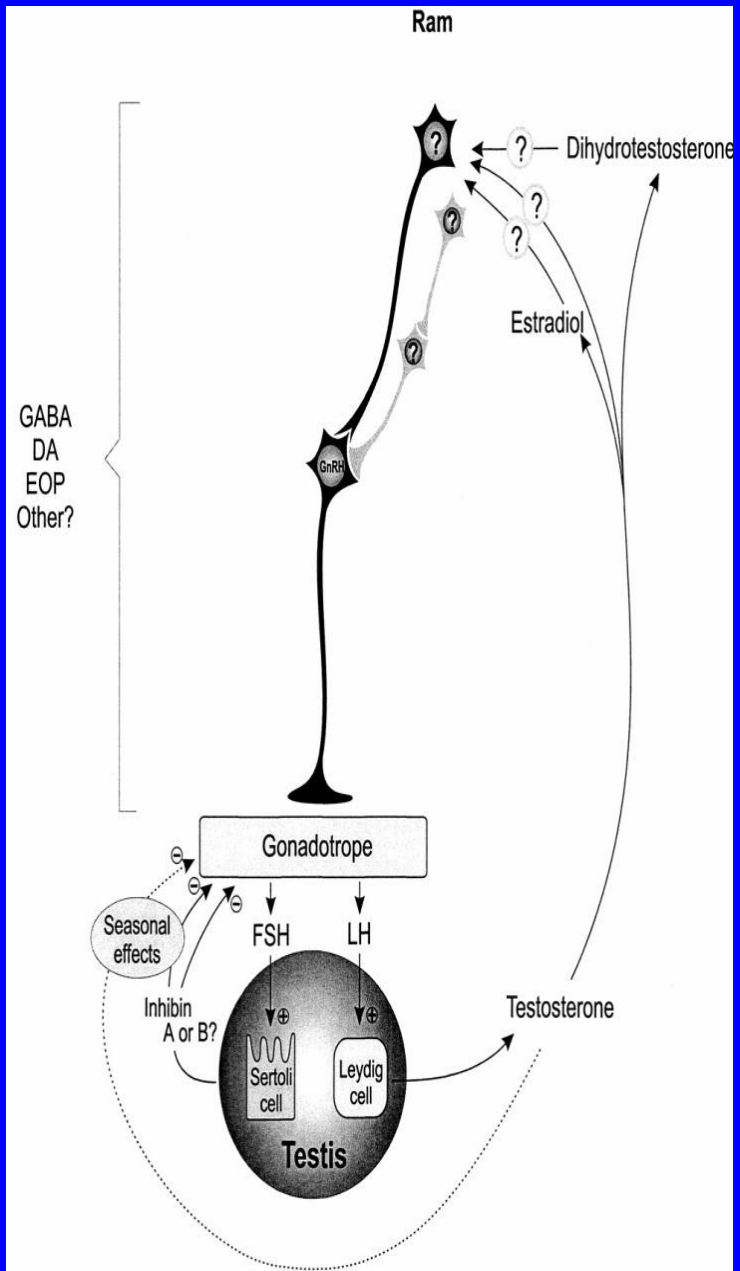
No receptors for sex steroids on GnRH neurons

= No direct interaction between sex steroids and GnRH neurons

Other neuronal pathways were reported to mediate the effect of gonadal steroids on GnRH neurons.

These neurons, in one side, possesses receptors for sex steroids and on the other side synapse with GnRH neurons.

At the site of synapse neurotransmitters are released



Role of Neurotransmitters in the control of testicular function :

(a) Before Puberty:

- Low level of sex steroid:

1- stimulates the release of inhibitory neurotransmitter e.g., Dopamine (DA), Gamma-aminobutyric acid (GABA)

2- inhibits the release of stimulatory neurotransmitter e.g., Acetylcholine (Ach), Norepinephrine (NE), Nitic oxide (NO) and glutamates.

Consequently,

inhibit Gn-RH secretion→ ↓ GnH secretion from Ant. Pit. → ↓ testicular function

(b) As Puberty progress (and during maturity):

- High level of sex steroid:

1- Inhibits the release of inhibitory neurotransmitter e.g., DA, GABA

2- Stimulates the release of stimulatory neurotransmitter e.g.,Ach, NE, NO and glutamates.

Consequently,

Stiimulate Gn-RH secretion → ↑↑ GnH sec. from Ant. Pit. → promote testicular function

- Testicle-Thyroid Relationship:

Every cell in the body is considered a target for thyroid gland. Therefore, normal output of thyroid hormones (euthyroidism) is necessary to maintain normal function of the body.

Hypothyroidism

(e.g summer sterility in Ram particularly in Europian breeds)

↓

Impairment of testicular function

(bad semen quality)

- Testicle-Adrenal Relationship:

Both testicles and zona reticularis of adrenal gland produce the same type of steroid hormone.

- Castration, leads to:

  1- Decrease androgen production

  2- Compensatory hypertrophy of adrenal gland.

- Injection of testosterone following unilateral adrenalectomy in rat:

  prevent the compensatory hypertrophy.

Factors affecting testicular function:

1- Hormones:

- Hypothalamo-hypophyseal-testicular relationship:
- Testicle-thyroid relationship:
- Testicle-adrenal relationship:

2- Environment:

- Effect of Season
- Effect of Temperature
- Effect of Light

3- Nutrition:

- Energy
- Vitamins
- Protein defeciency
- Minerals

4- Psychic factors:

5- Noxious agents:

- Radiation
- Pathological conditions

Effect of Season:

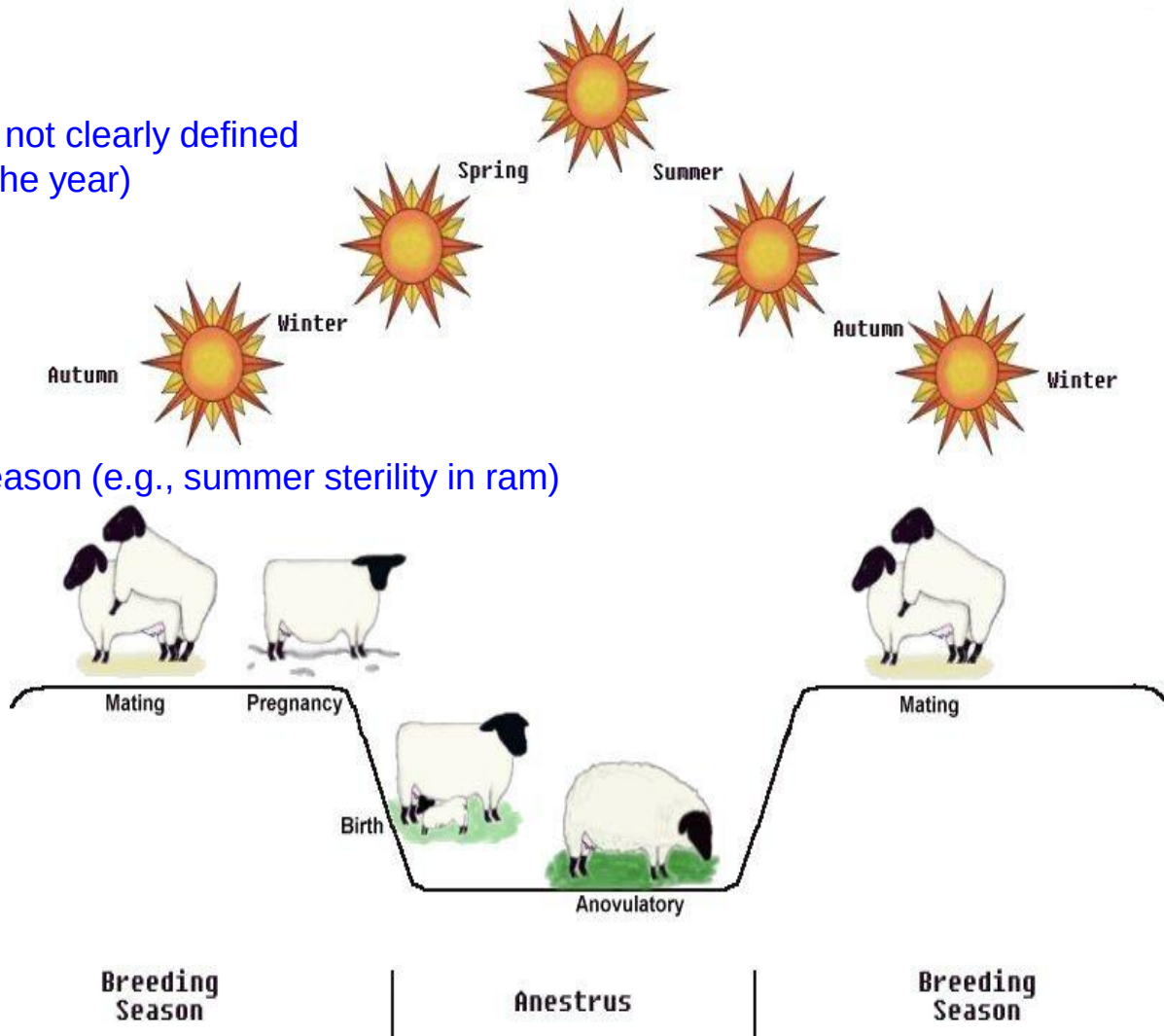
- Season reflects hormonal and temperature cycles

- Native breeds:

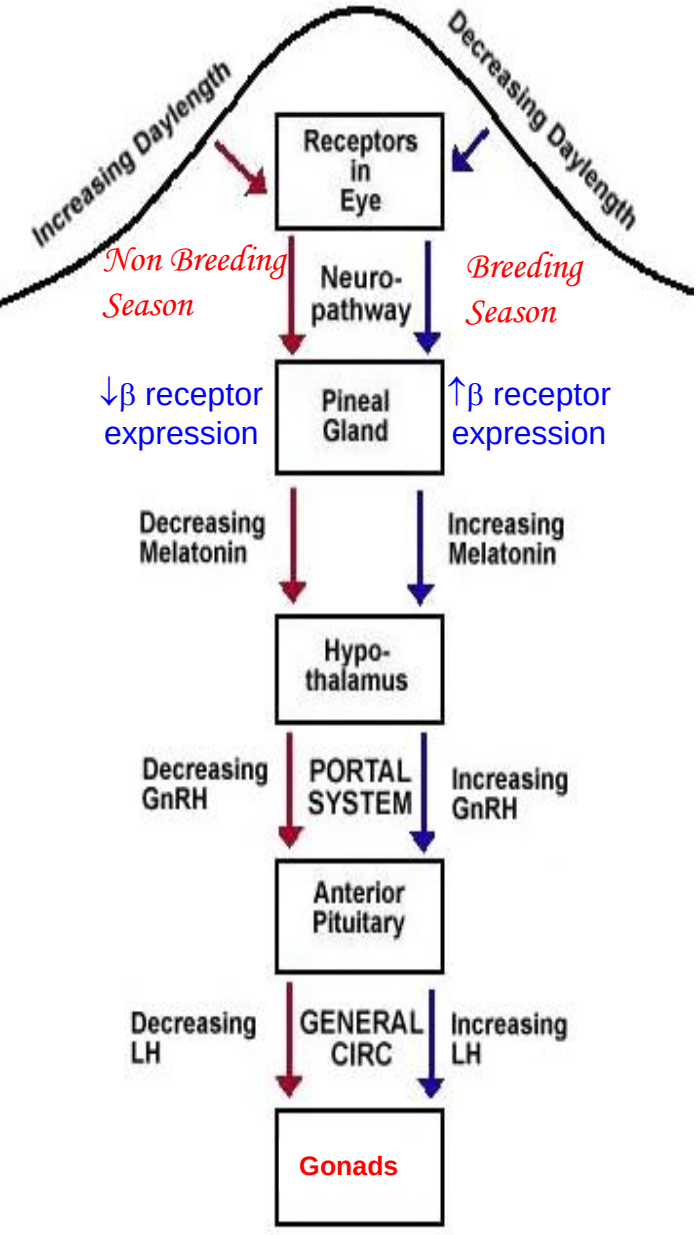
Typical breeding season is not clearly defined (i.e., can be used for breeding allover the year)

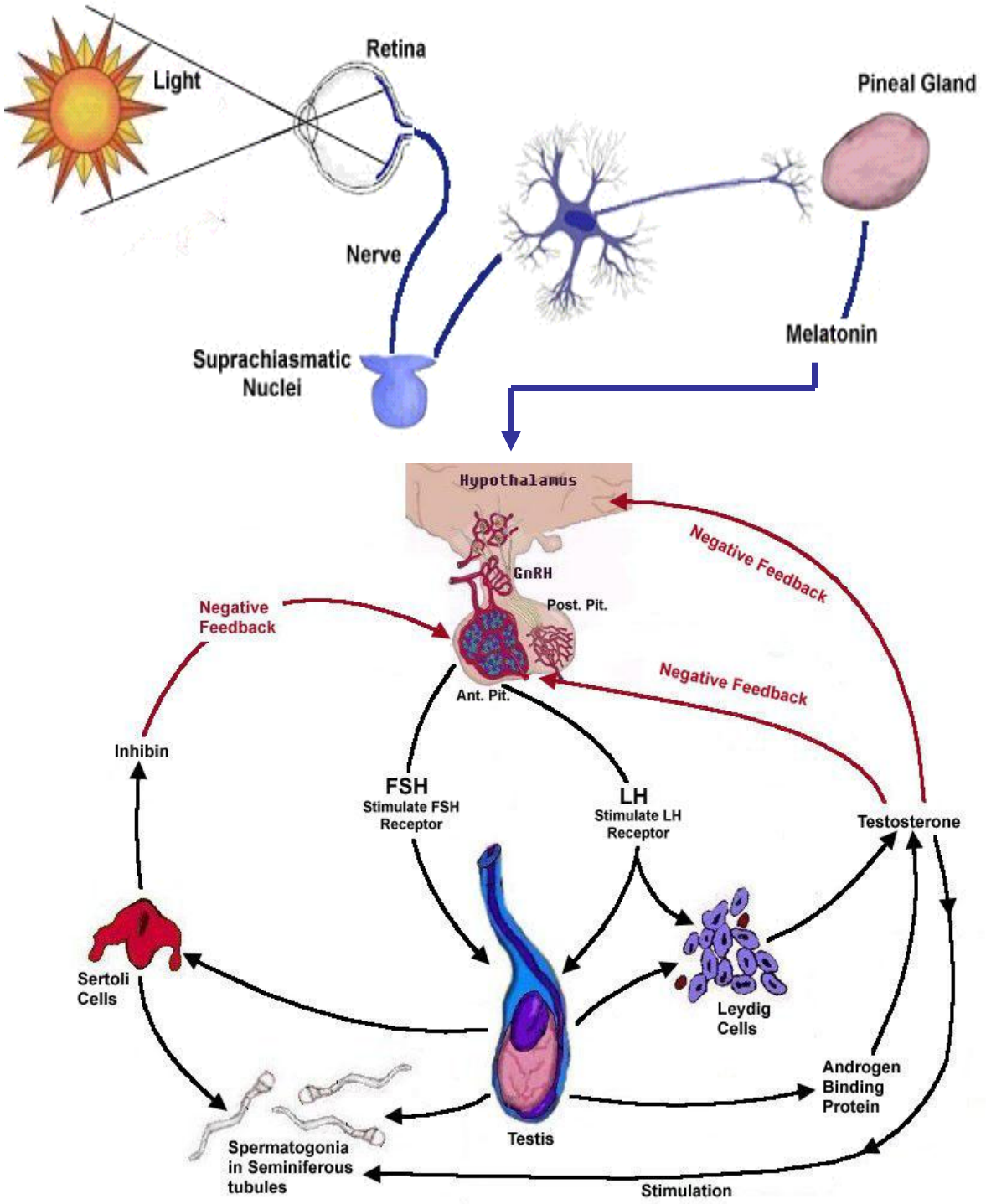
- Foreign breeds:

exhibits typical breeding season (e.g., summer sterility in ram)



Effect of Light:





Effect of Temperature:

Testicular thermoregulation is necessary since sperm are not produced at core body temperature

Temperatures 3-5°C less than body temperature are required for Spermatogenesis to occur.

Q: What are the factors involved in thermoregulation mechanism of mammalian testis?

Factors involved in Thermoregulation mechanism of the Testis

(A) Role of Scrotum

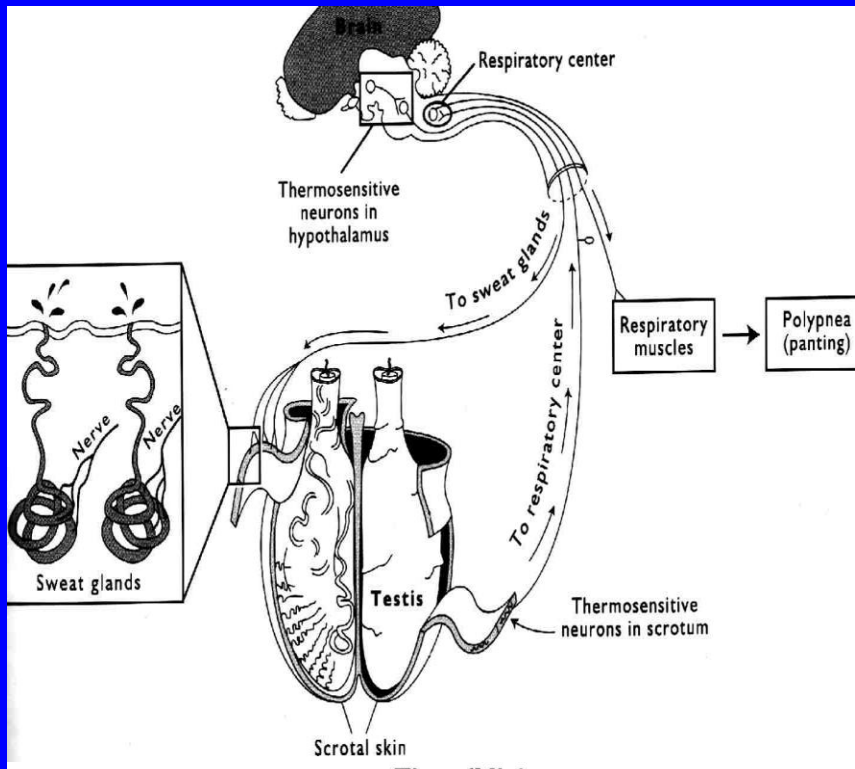
1- Change in testis location:

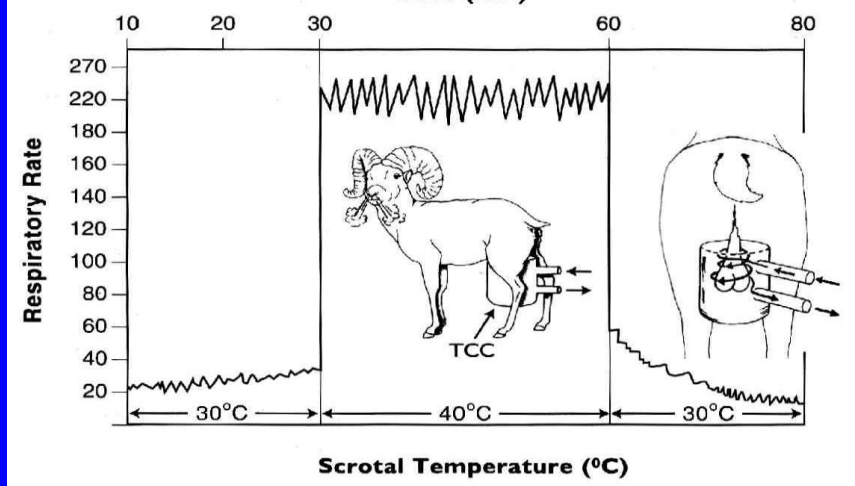
- Cold weather:

External Cremaster Muscle
↓
Contract
↓
pull testes closer to body

- Hot weather:

External Cremaster Muscle
↓
Relax
↓
Testes drawn away from the body





Factors involved in Thermoregulation mechanism of the Testis

2- Change in scrotal surface area

- Cold weather:

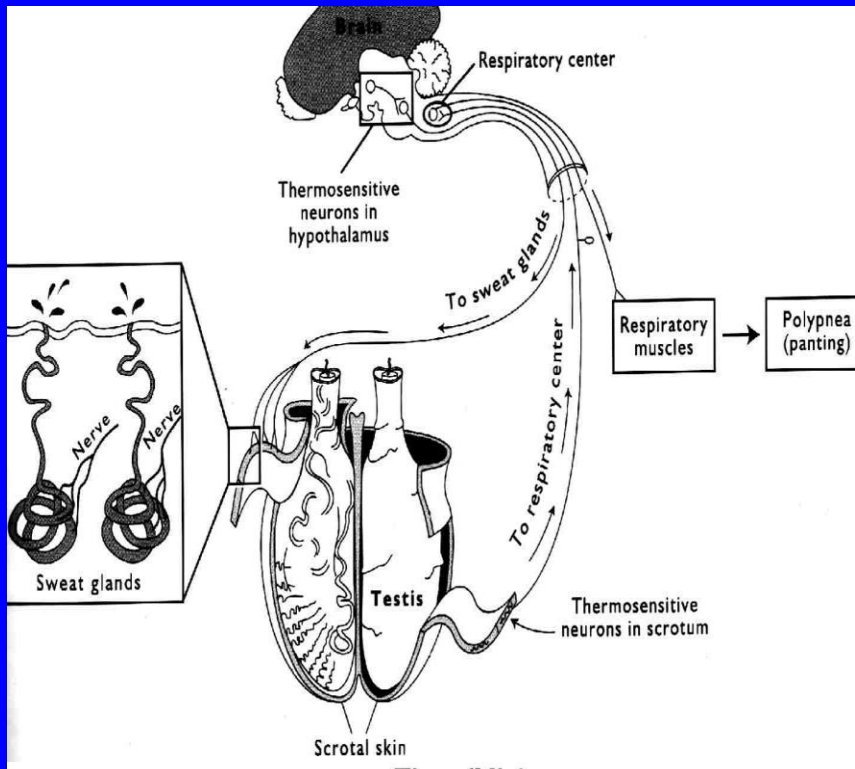
Smooth muscle of Tunica dartos

↓

Contract (Wrinkles skin)

↓

Reducing surface area of scrotum & lifting it upwards

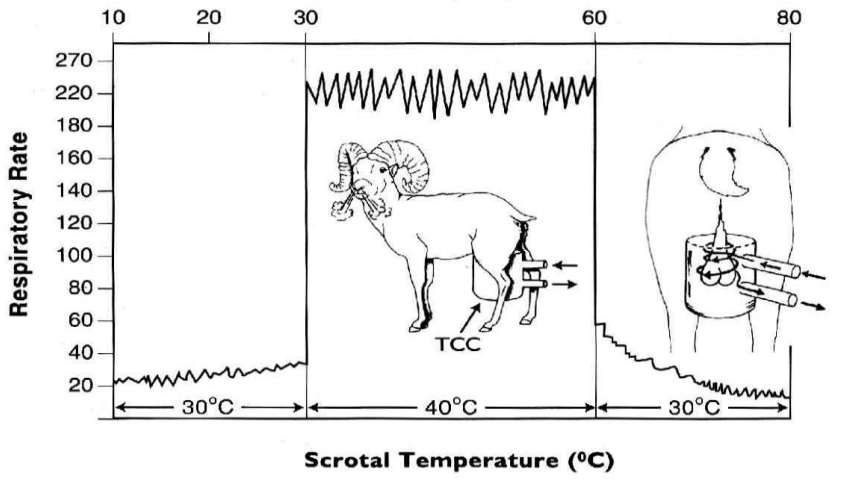


3- Scrotal skin is :

- **Thin (lack S/C fat)** and **has a few hairs** → Low insulation → promotes natural loss of heat via convection, radiation and conduction

- **Rich in Sweat gland** → ↑ heat loss via evaporation of sweat.

- **Rich in Thermoreceptors,** which on stimulation cause increase heat loss via:
  - ↑ sweating
  - ↑ respiratory rate



Factors involves in Thermoregulation mechanism of the Testis

(B) Role of Blood supply to the Testis:

1- Testicular artery:

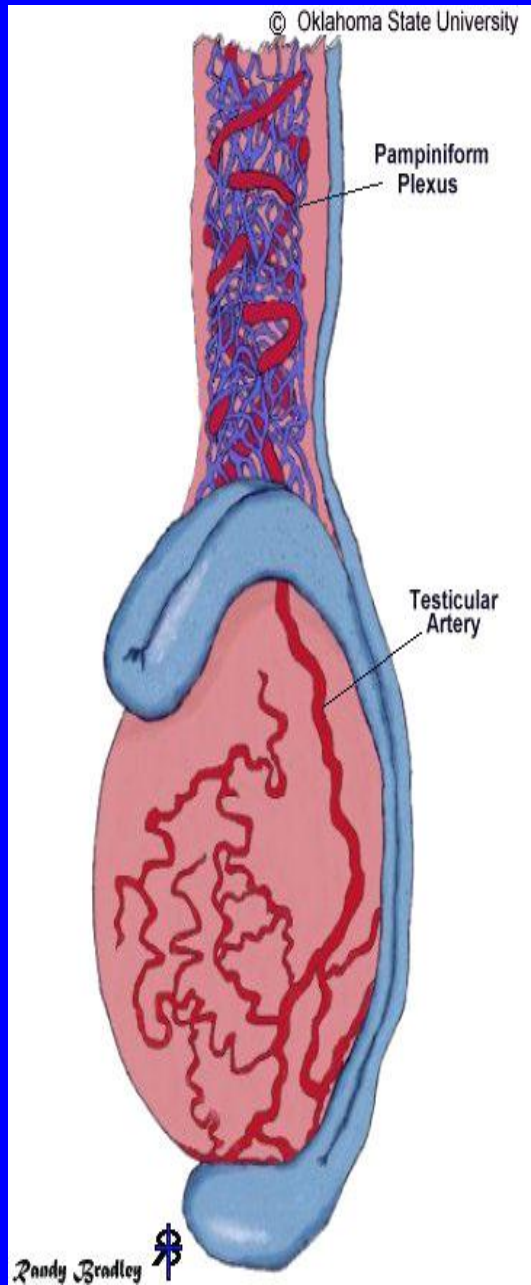
- Tortious
- Highly convoluted course
- Located near the surface of the testis.

Promote direct heat loss from testis

2- Testicular veins:

- Coil around the testicular artery to form **pampiniform plexus.**

- Cooler venous blood in the pampiniform plexus cools arterial blood entering the testis.



Factors affecting testicular function:

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- Hypothalamo-hypophyseal-testicular relationship:
- Testicle-thyroid relationship:
- Testicle-adrenal relationship:

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- Effect of Temperature
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3- Nutrition:

- Energy
- Vitamins
- Protein defeciency
- Minerals

4- Psychic factors:

5- Noxious agents:

- Radiation
- Pathological conditions

Effect of Nutrition (Energy – Protein – Vitamins – Minerals)

(a) Energy:

*** Effect of Underfeeding for long period:**

1- Prepuberty:

delay the onset of puberty as it interferes with GnH synthesis and/or release.

2- After puberty:

- bad semen quality
- Decrease lipido

N.B:

In adult bull, feed intake can be restricted to the point where 25% of body weight have been exhusted (reduced) without marked decrease in semen quality or libido

*** Effect of overfeeding (e.g., Show animals):**

- Obesity leads to:
  - withdraw sex steroid from circulation
  - fat deposition in scrotum →interfer with thermoregulation mechanism of the testis. –

- Generally fatty animals are more susceptable to stress and climatic factors than len animals e.g., foot and leg diseases

Effect of Nutrition (Energy – Protein – Vitamins – Minerals)

(b) Protein deficiency (long period):

- Prepuberty:

delay the onset of puberty.

- Young Bull:

- bad semen quality
- Decrease libido

- Mature Bull:

Can shift on body protein to maintain spermatogenesis and GnH production.

NB:

In adult bull, feed intake can be restricted to the point where 25% of body weight have been exhusted (reduced) without marked decrease in semen quality or libido

Effect of Nutrition (Energy – Protein – Vitamins – Minerals)

(c) Vitamins deficiency:

1- Vitamin A deficiency:

Prolonged deficiency→ degeneration of germinal epithelium →↓ sperm count

N.B:

Vit. A is essential for the integrity of epithelial cell all over the body.

2- Vitamin E:

- essential for **testosterone** synthesis
- deficiency leads to atrophy of germinal epithelium in rat only

(d) Mineral deficiency:

1- Calcium and Phosphorus deficiency:

- not affect testis function, unless sever deficiency of both
- Phosphorus is essential for DNA multiplication

2- Molybdenum and Cadmium poisoning:

- testicular degeneration

Factors affecting testicular function:

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- Energy
- Vitamins
- Protein defeciency
- Minerals

4- Psychic factors:

5- Noxious agents:

- Radiation
- Pathological conditions

(IV) Psychic factors:

Provoke	Suppress
male sex activity	
1- **Vision** = Bull see estrus female 2- **Olfactory** = Bull smell sex phermone in vaginal secretion of estrous female 3- **Gastatrory** = Bull lick vaginal secretion of estrous female 4- **Auditory** = Bull hear the sound of estrous female	1- Bad handling of male 2- Penile injury 3- Fear, pain, accident which occurs at the time of service
Mechanism: Social stimuli → afferent sensory stimuli to hypothalamus, resulting in	
stimulating	inhibiting
The secretion of GnH from anterior pituitary gland	

(V) Noxious agents:

(a) Radiation (X- and γ- rays):

Reproductive tissues differ in their sensitivity to radiation e.g.,

- Germinal epithelium→ highly sensitive (especially spermatognium type A)
- Leydig cells → relatively resistant, so libido not affected

(b) Pathological conditions:

- Heredity (congenital) e.g.,

1- Cryporchidism = lack of testis descend in the scrotum and thus interfers with thermoregulation of testis (Common in boar and stallion)

- bilateral→ sterile animal
- Unilateral→ infertile animal (reduce sperm producing capacity)

2- Uni- or bi- lateral aplasia or **hypoplasia** of testis, epididymis.

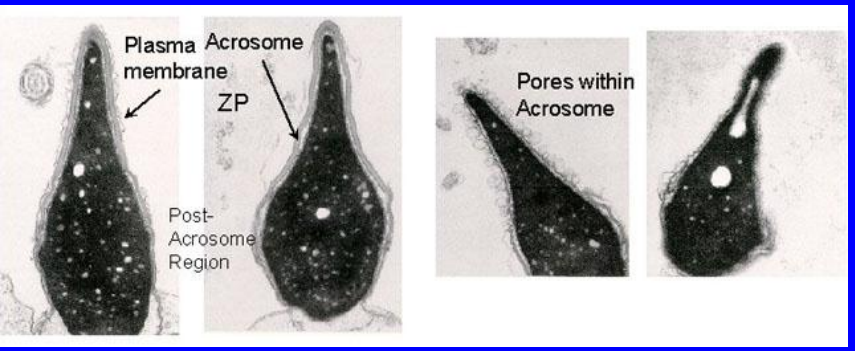
- Acquired e.g.,

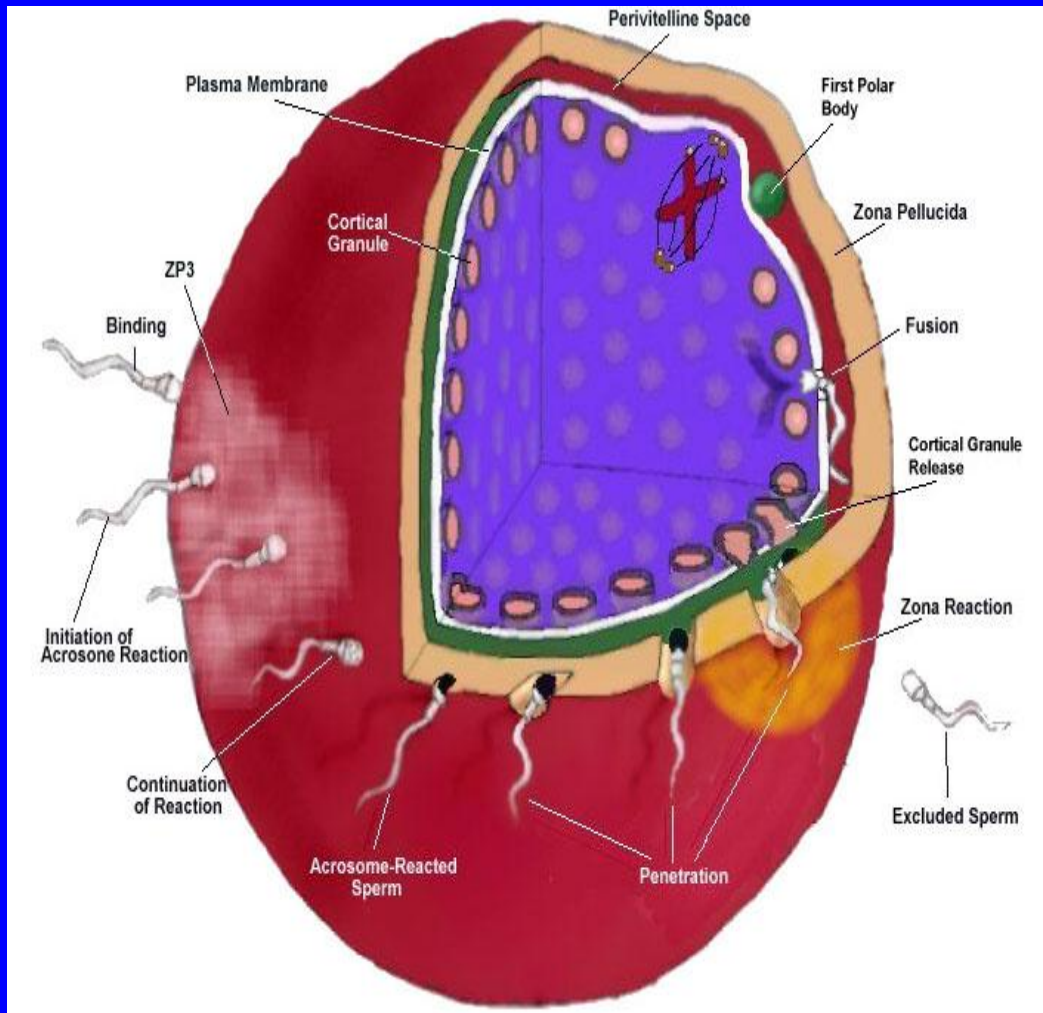
Trauma, inflammation, degeneration, ..etc of any part of reproductive tract.

- Immunological factors e.g.,

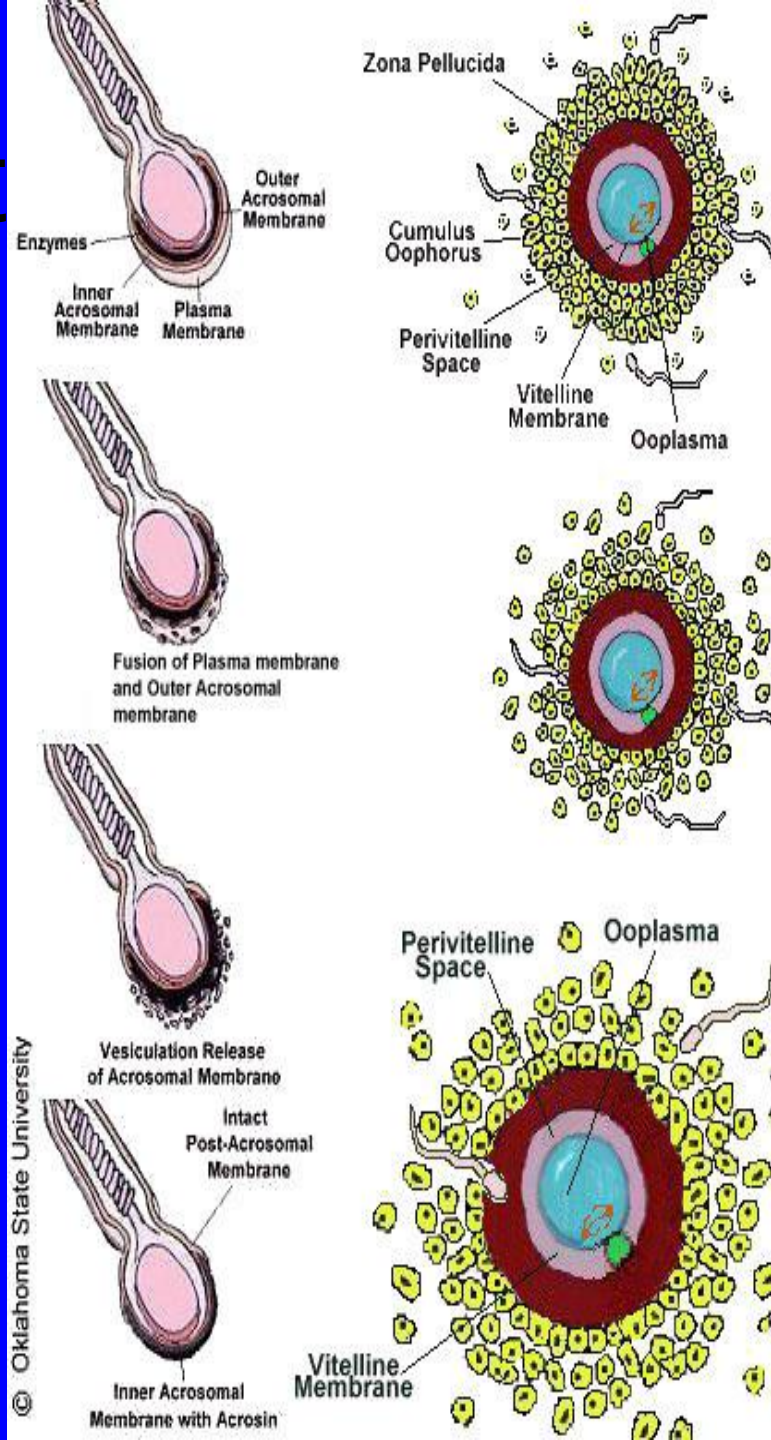
autoimmune orchitis.

Fertilization



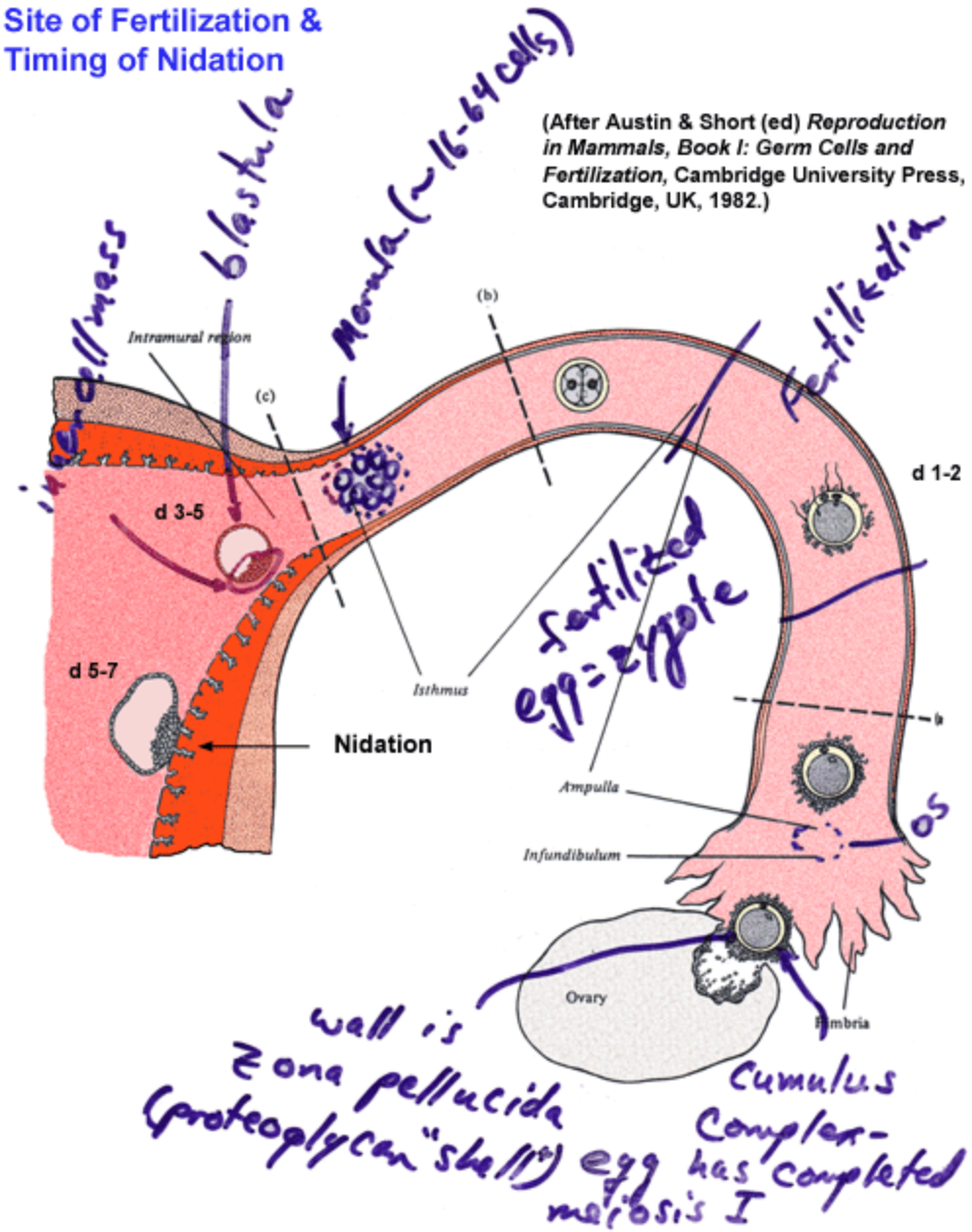


Sperm penetration t

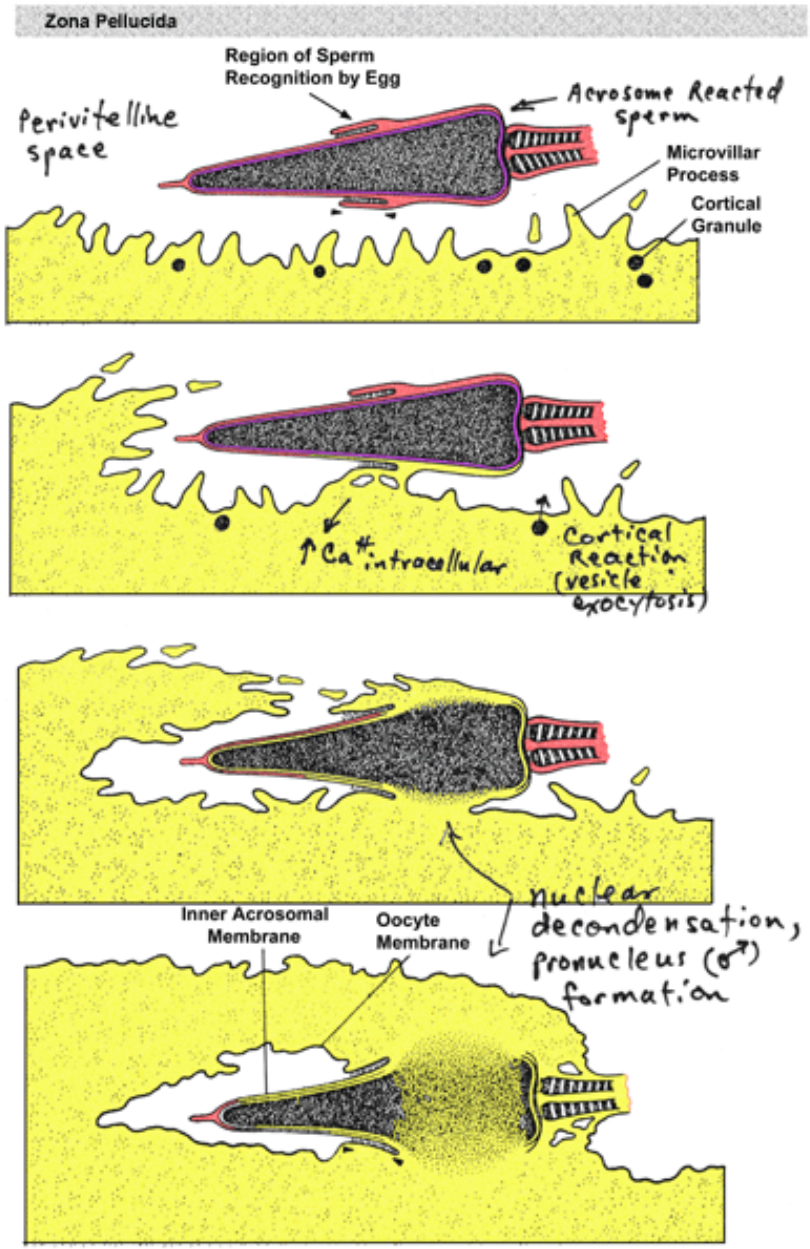


Fertilization

Site of Fertilization & Timing of Nidation



Fertilization: Sperm/Egg Fusion



Modified from Bedford & Cooper, *Cell Surface Reviews, V. 5, Membrane Fusion*, Poste & Nicolson (ed), Elsevier/North Holland Biomedical Press: Amsterdam, 1978.