
جامعة القاهرة
فرع بني سويف
كلية الطب البيطري

Physiology Department

Physiology of Male Reproduction

Prepared by

Prof. Dr. Shawky Soliman Ibrahim

Professor of Physiology

Faculty of Veterinary Medicine, Beni-Suef University

Vice President of Beni-Suef University

Outlines on Physiology of Male Reproduction

1- **Puberty and Sexual Maturity:**
2- **Overview of the Male Reproductive System:**
3- **General Functions of Male Reproductive System:**
4- **Testicular Anatomy:**
5- **Functions of Testes:**
   - Germinal Epithelium (Spermatogenesis)
   - Sertoli Cells
   - Leydig Cells
6- **Factors Affecting Testes Function:**
7- **Secondary Sex Organs:**
   - **(A) Spermatic Ducts:**
     Rete Testis, Efferent Ductules, Epididymis, Ductus Deferens & Ejaculatory Duct.
   - **(B) Accessory glands:**
     Ampullae, Seminal Vesicles, Prostate & Bulbourthral (Cowper's) Glands.
8- **Spermatozoa:**
9- **Fertilization:**

Puberty

Puberty = Time of adolescence

= Onset of reproductive competence, i.e., both → behavior & function

= age at which endocrine & gametogenic functions of gonads was 1st developed → *Reproduction is possible*

Puberty

In male:

= age at which ♂ can give well developed, alive spermatozoon which can be detected in semineferous tubule, although it is not yet ejaculated.

In other opinion:

= age at which ♂ can give well developed alive ejaculated spermatozoon.

In female:

= age at which ♀ exhibits its 1st estrus

Sexual maturity

= age at which animal can be used for breeding i.e.,

♂ gives spermatozoon which have the ability

For

Fertilization

Causes of Puberty (Factors induce Puberty):

1- Critical body weight must be reached:

2- Change in hypothalamus feedback sensitivity:

3- Development and maturation of neurotransmitter system in the CNS:

Causes of Puberty (Factors induce Puberty):

1- Critical body weight must be reached:

There is a great relationship between body weight (and consequently, nutrition) or growth-rate and the onset of puberty

	% Mature weight at puberty
Cattle	65%
Sheep	40-60%
Cat	80% (2.3-3.2 kg)

Bitch: attains adult body weight a few months before puberty.

N.B:

Leptin (secreted by fat cells) → act on satiety producing center → may be the link between B wt & puberty.

2- Change in hypothalamus feedback sensitivity:

- Before puberty:

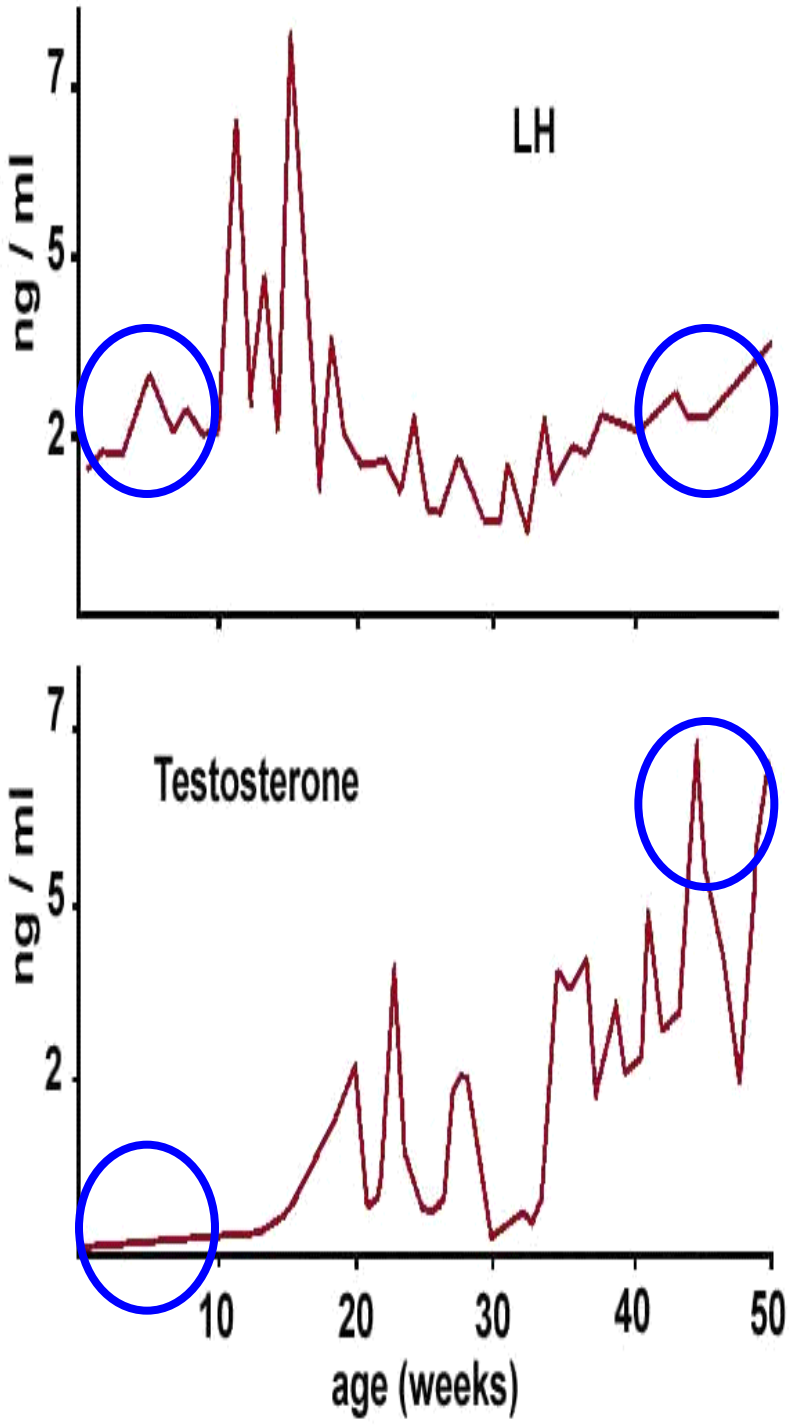
Hypothalamus and pituitary gland are highly sensitive to feedback inhibition induced by low level of sex steroids (estrogens or testosterone) → suppress LH & FSH

Evidence:

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

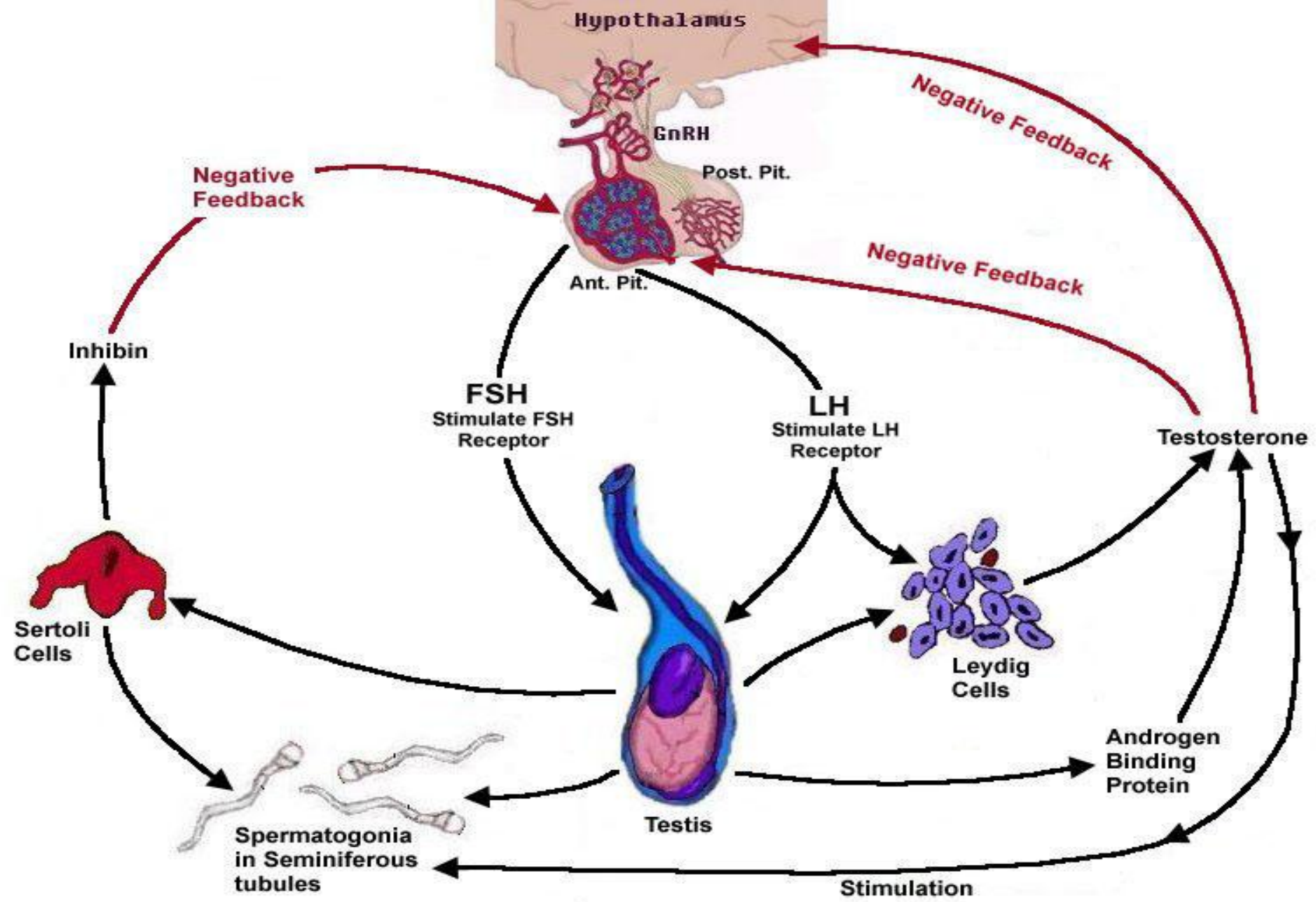
- As Puberty progresses:

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

3- Development and maturation of neurotransmitter system in the CNS:

Brain is the initiator of reproductive cycle. Explain?

- Sex steroids affect receptors sites at certain neurons in the brain. These neurons on the other side synapse with GnRH neurons of the hypothalamus.

- At the site of synapse:

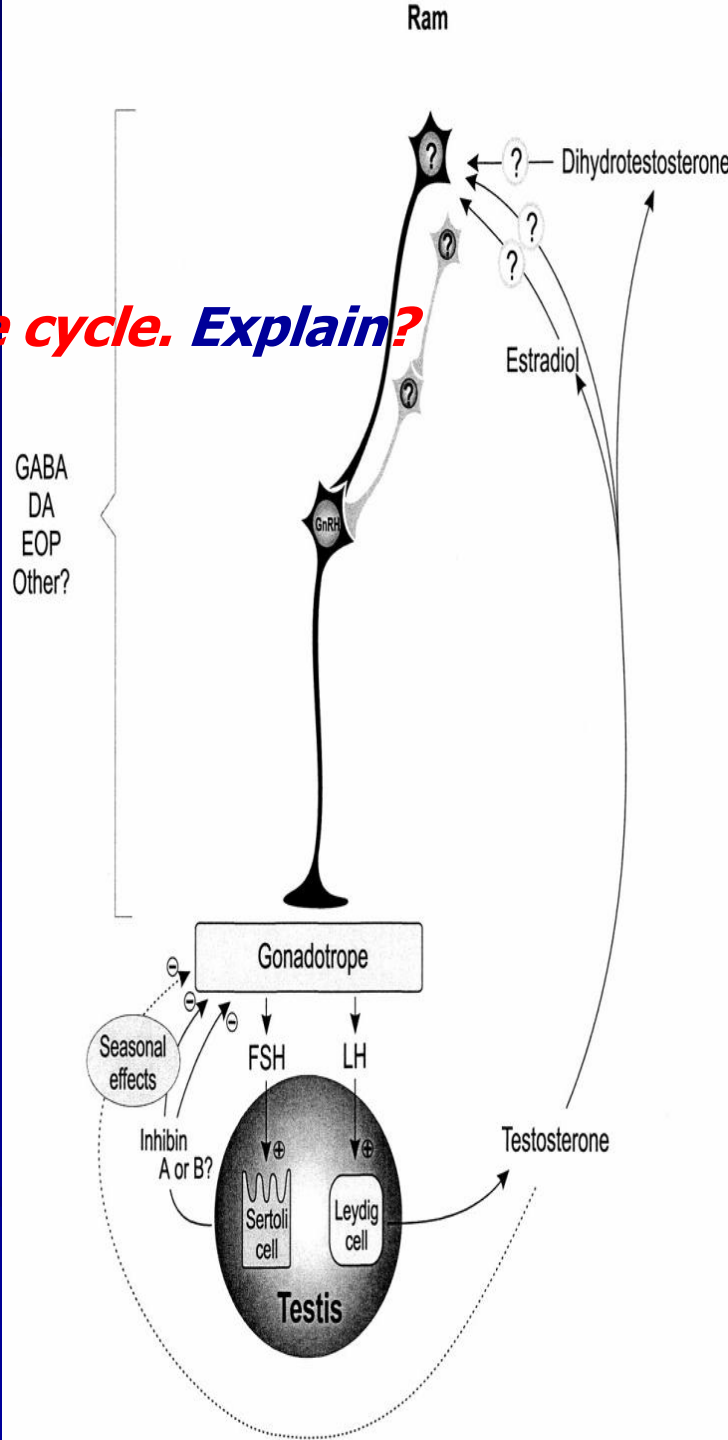
Neurotransmitters

are released

Evidence:

There is No receptors for sex steroids on GnRH neurons. Consequently,

There is No direct interaction between sex steroids and GnRH neurons.



Before Puberty (Calf-hood)

- 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),
- Nitic oxide (NO)
- Norepinephrine (NE),
- Glutamates.

↓

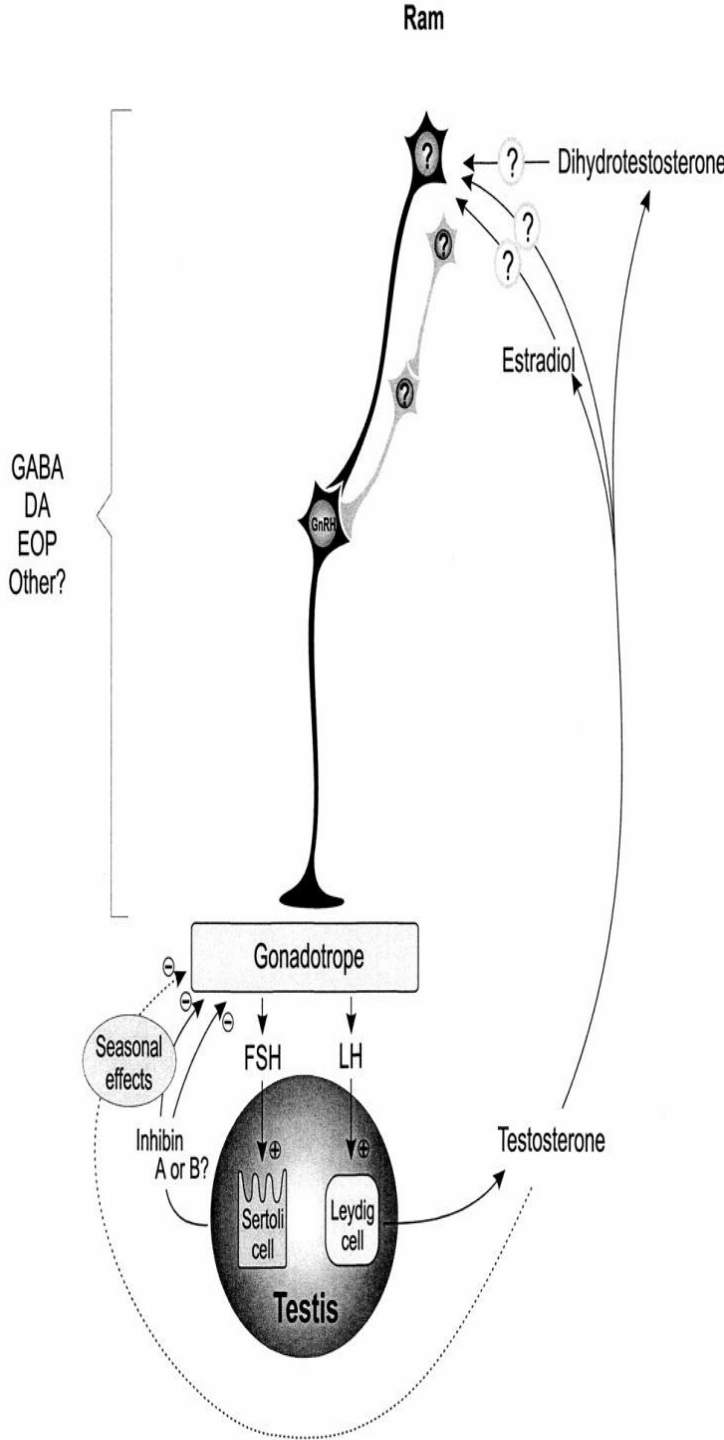
inhibits Gn-RH secretion

↓

↓ GnH secretion from Ant. Pit.

↓

↓ Testicular function



As Puberty progress (mature animal)

- High level of sex steroid:

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

2- Stimulates the release of stimulatory neurotransmitters e.g., Ach, NE, NO and Glutamates.

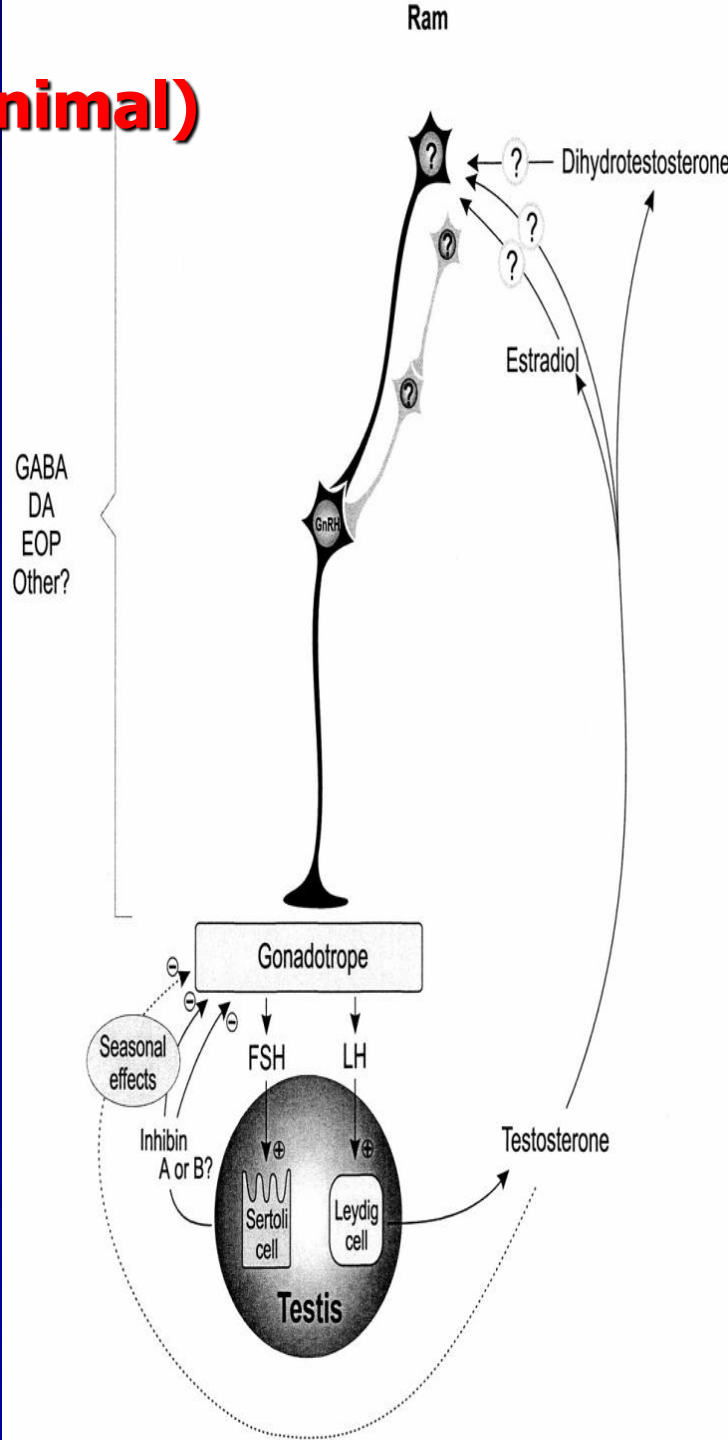
Stimulate Gn-RH secretion

↓

↑↑GnH secretion from Ant. Pit.

↓

↑ Testicular function



Factors affecting the time of puberty onset:

(I) Genetic:

1- Sex
2- Breed

(II) Environmental factors:

1- Nutrition:
2- Season of birth (in seasonal breeders)
3- Climate:
4- Photoperiod:
5- Social interaction:
6- Stress:

1- Sex:

♀ reach puberty (2-4 months) earlier than ♂

	Age at Puberty (months)	
	Female	**Male**
Cattle	8-11	9-12
Sheep	6-8	7-8 (range 4-12)
Goat	6-8	7-8 (range 4-12)
Horse	18 (range 10-24)	18 (range 12-24)
Cat	6-9 (range 5-12)	8-10 (range 6-15)
Dog	Several weeks earlier than male	6-12 (range 5-12)
Swine	4-7	4-8

2- Breed:

- Cattle:

Dairy breed reaches puberty earlier than beef breed

Breed	Puberty age (months)
Jersy	8
Holstein	11
Ayr-shire	13
Brahman	15-18

- Dog:

Smaller breeds attain puberty earlier than larger breeds since the latter attain adult body weight much earlier

- Goat:

Breed	Puberty age (months)
Pygmy (Small size = Lab.goat in USA)	3
Anglo-Nubian goat	15

- Cat:

- In many cats → puberty is observed **by 6-9 Ms of age (r**ange 5-12 Ms)

- Purebred → attain puberty later than domestic or mixed breed cats.

- Free-roaming cats → may reach sexual maturity earlier than those kept constantly in the home.

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1- Nutrition:

There is a great relationship between nutrition, body weight or growth-rate and the onset of puberty.

Therefore,

1- Adequate ration (quality and quality), good pasture, grain, fresh water and iodized salt are required to hasten the onset of puberty

2- It is necessary to calculate and supply the animal with its nutrient requirements for maintenance, growth, production and reproduction.

- Nutrient required for successful reproduction:

a) Energy b) Proteins

c) Specific nutrients: e.g, phosphorus, calcium, copper, cobalt, Manganese, iodine and vitamin A.

- Mechanism through which nutrition affects the process of reproduction:

a) Direct: through direct effect on the metabolism of reproductive organs eg., ovaries and testis.

b) Indirect: through the effect on the metabolism of endocrine glands (e.g, pituitary, thyroid, ..etc) which regulate gonadal function.

Example:

In Mare:

Nutritional deficiencies or malnutrition during the critical period of accelerated growth (at 6-12 Ms of age in mare) will delay puberty for up to 6 Ms or more.

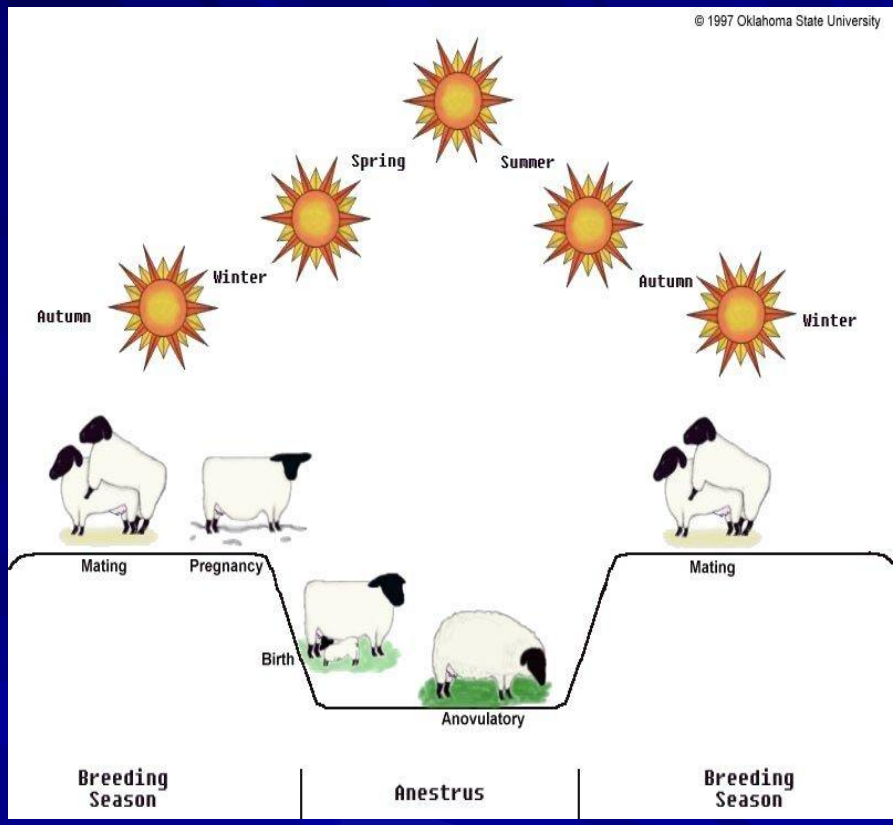
2- Season of birth (in seasonal breeder):

Ewe lambs:

which are born at early spring (green season) reach puberty at earlier age (6 months) than those born in late spring or early summer (400-500 days). Comment?

- During early spring, the reproductive axis (hypothalamus-pituitary-gonad) is initiated early.

- While, during late spring, the reproductive axis pass the stimulating effect.



Filly Foals:

which are born early in the year (Spring= Jan. or Feb.) reach puberty earlier (16-17 months) than those born late in the year i.e., July or August (21-22 months)

3- Climate:

Animals living in tropics (near the equator) reach puberty at an earlier age than those in temperate climates. Explain?

Tropics there is no distinct change in the length of photoperiod throughout the year, unlike temperate area were the length of day light varies greatly throughout the year

4- Photoperiod:

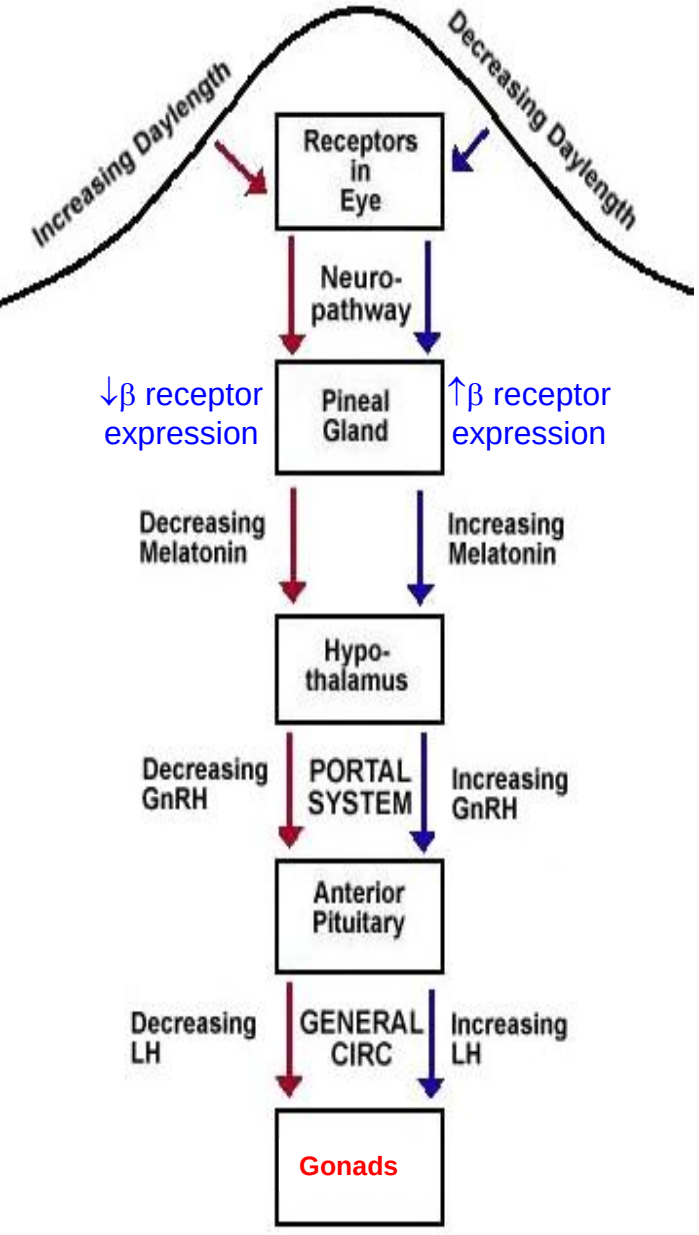
Ewe:

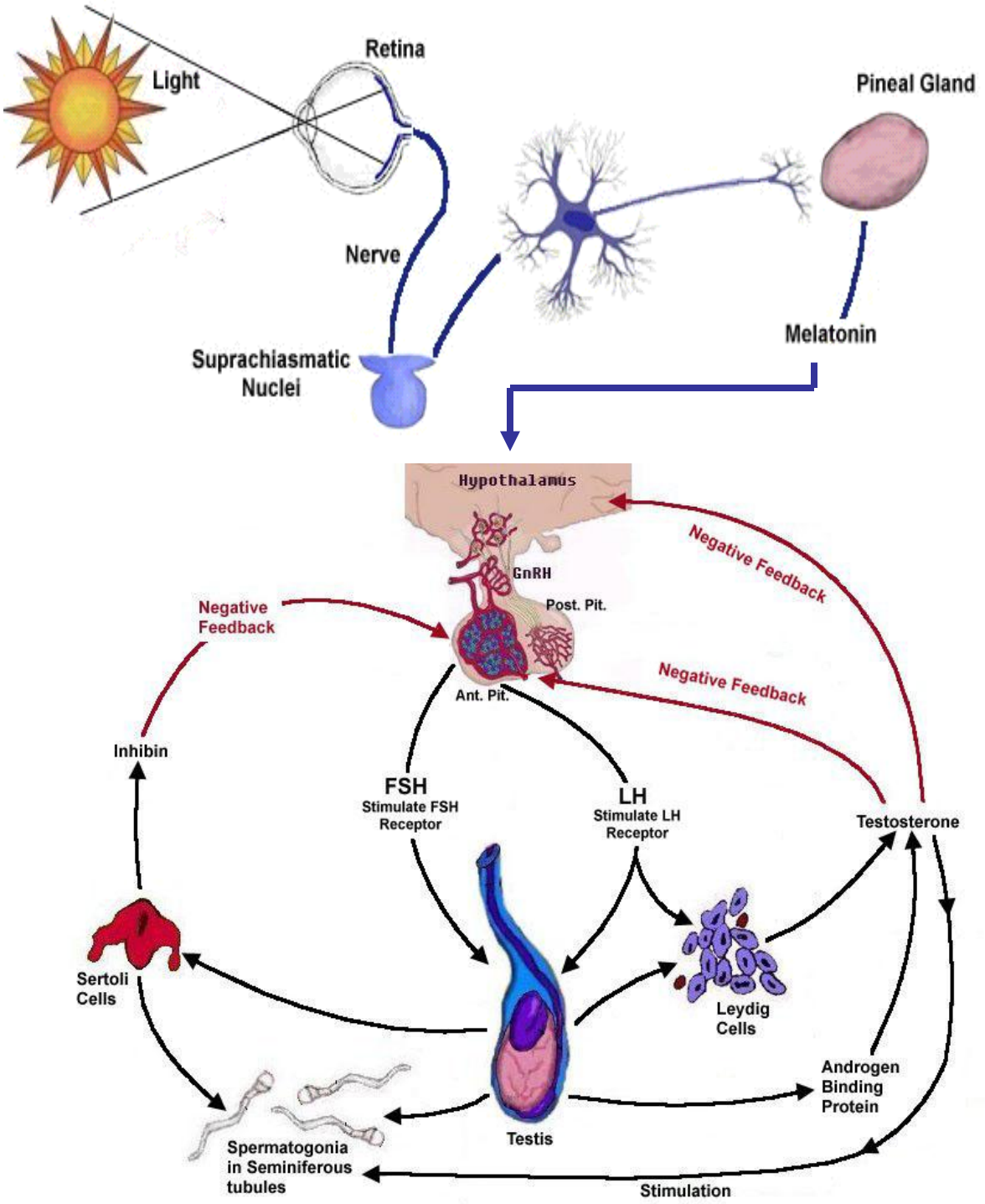
Sort day light breeder

Mare:

Long day light breeder

Effect of Light (lamb)





5- Interaction with the opposite sex (Social interaction):

- Interaction of the opposite sex → favors early onset of puberty

- Presence of the same sex → delays the onset of puberty.

6- Stress:

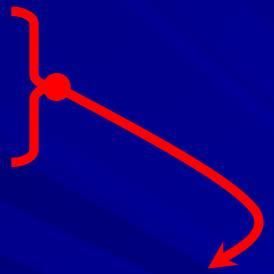
Reproduction is a *luxury function*

i.e., under bad condition all sex activities are depressed.

Therefore,

Any stress factor (during the prepubertal period) such as:

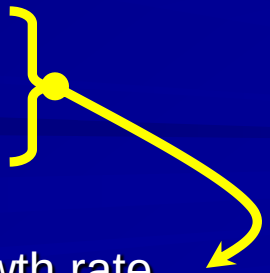
- poor management,
- disease e.g., heavy parasitic infestation,
- adverse environmental condition



will retard the onset of puberty.

Thus,

1- adequate housing,
2- routine vaccination against common diseases,
3- adequate deworming program



are necessary to insure optimum growth rate and early attainment of puberty.

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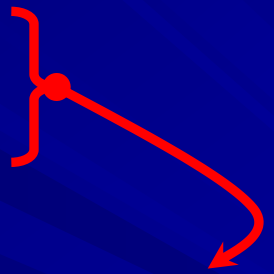

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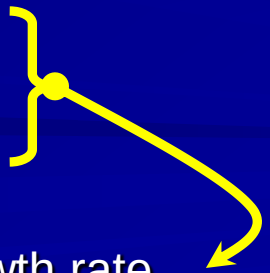

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Overview of Male Reproductive System

Overview of male Reproductive System:

(I) Primary sex organs:

= gonads; Testis

(II) Secondary sex organs

= organs other than gonads;

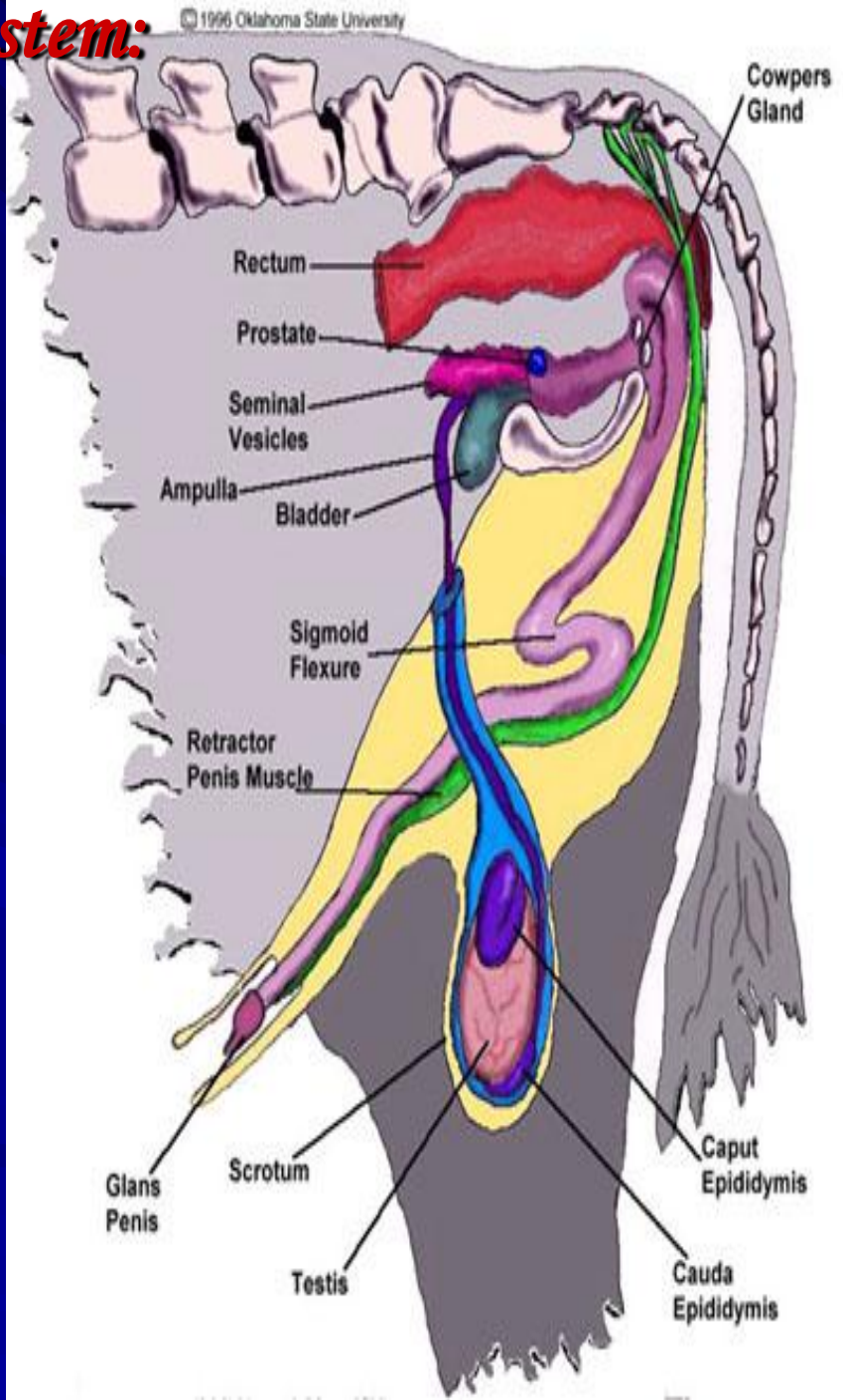
A) Ducts:

- Efferent ductules
- Epididymis (Head – Body - Tail)
- Ductus (vas) Deferense (DD)
- Ejaculatory duct

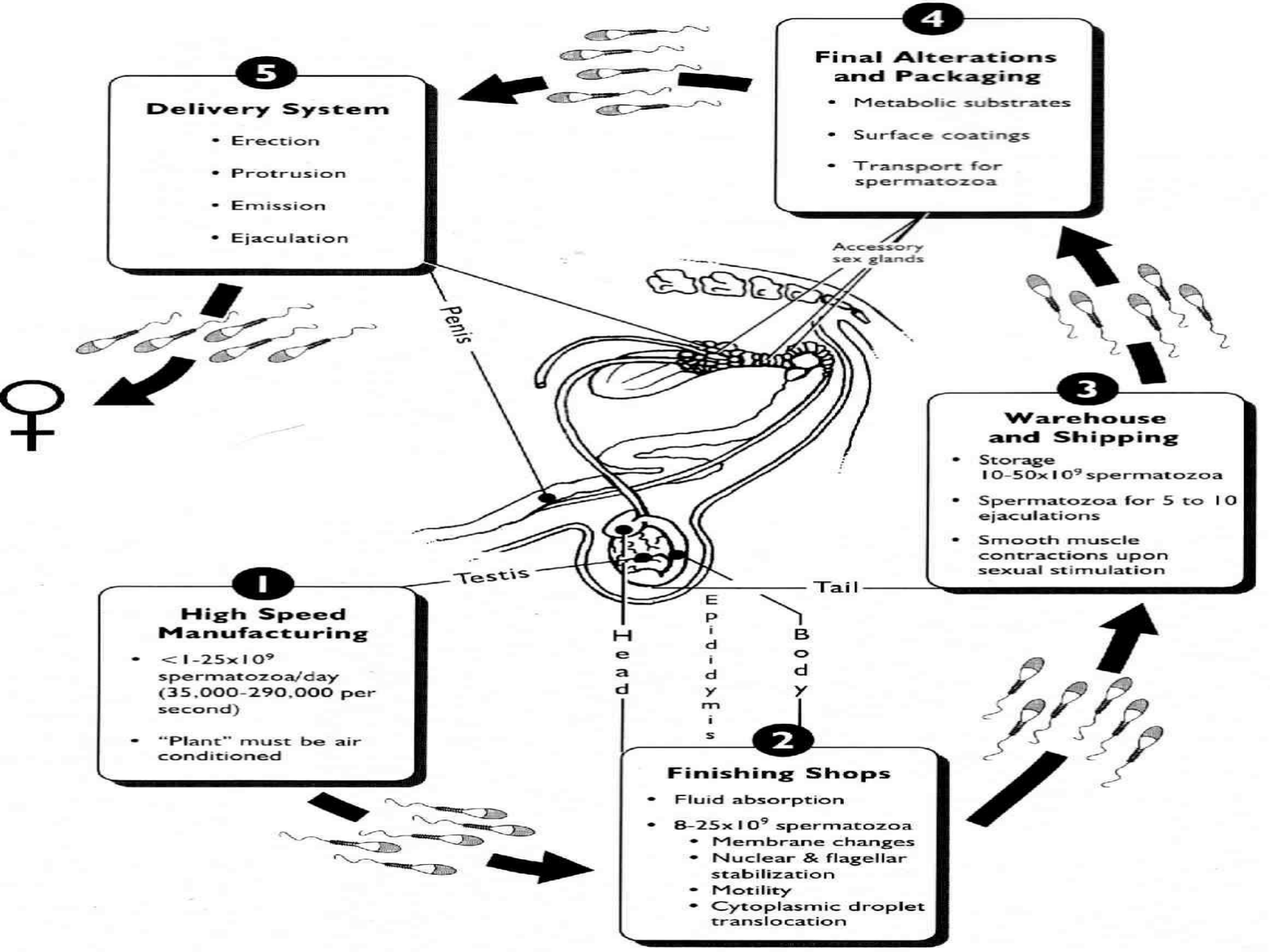
B) Accessory glands:

- Ampulla (A).
- Seminal vesicles (SV),
- Prostate (PG)
- Bulbouretheral gland (BuG) = Cowper's gland.

C) Penis:



General function of Male Reproductive System


4
Final Alterations and Packaging
• Metabolic substrates
• Surface coatings
• Transport for spermatozoa
5
Delivery System
• Erection
• Protrusion
• Emission
• Ejaculation
Accessory sex glands
Penis
3
Warehouse and Shipping
• Storage 10-50x10⁹ spermatozoa
• Spermatozoa for 5 to 10 ejaculations
• Smooth muscle contractions upon sexual stimulation
Testis
Tail
1
High Speed Manufacturing
• <1-25x10⁹ spermatozoa/day (35,000-290,000 per second)
• "Plant" must be air conditioned
Head
Epididymis
Body
2
Finishing Shops
• Fluid absorption
• 8-25x10⁹ spermatozoa
• Membrane changes
• Nuclear & flagellar stabilization
• Motility
• Cytoplasmic droplet translocation

Primary Sex Organ

TESTIS