


A network diagram with a central node and many peripheral nodes connected by lines, set against a blue and green gradient background.

# Chapter 12 Reproduction

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- The primary reproductive organs are known as gonads:  
Testis in the male  
Ovary in the female
- The gonads serves dual function:  
(1) Gametogenesis take places — sperm/ova  
(2) Secrete steroid hormones (sex hormone)
- Primary sex hormones:  
Testosterone in the male  
Estradiol and progesterone in the female



**Section 1**  
**Testis endocrine &  
male reproduction**

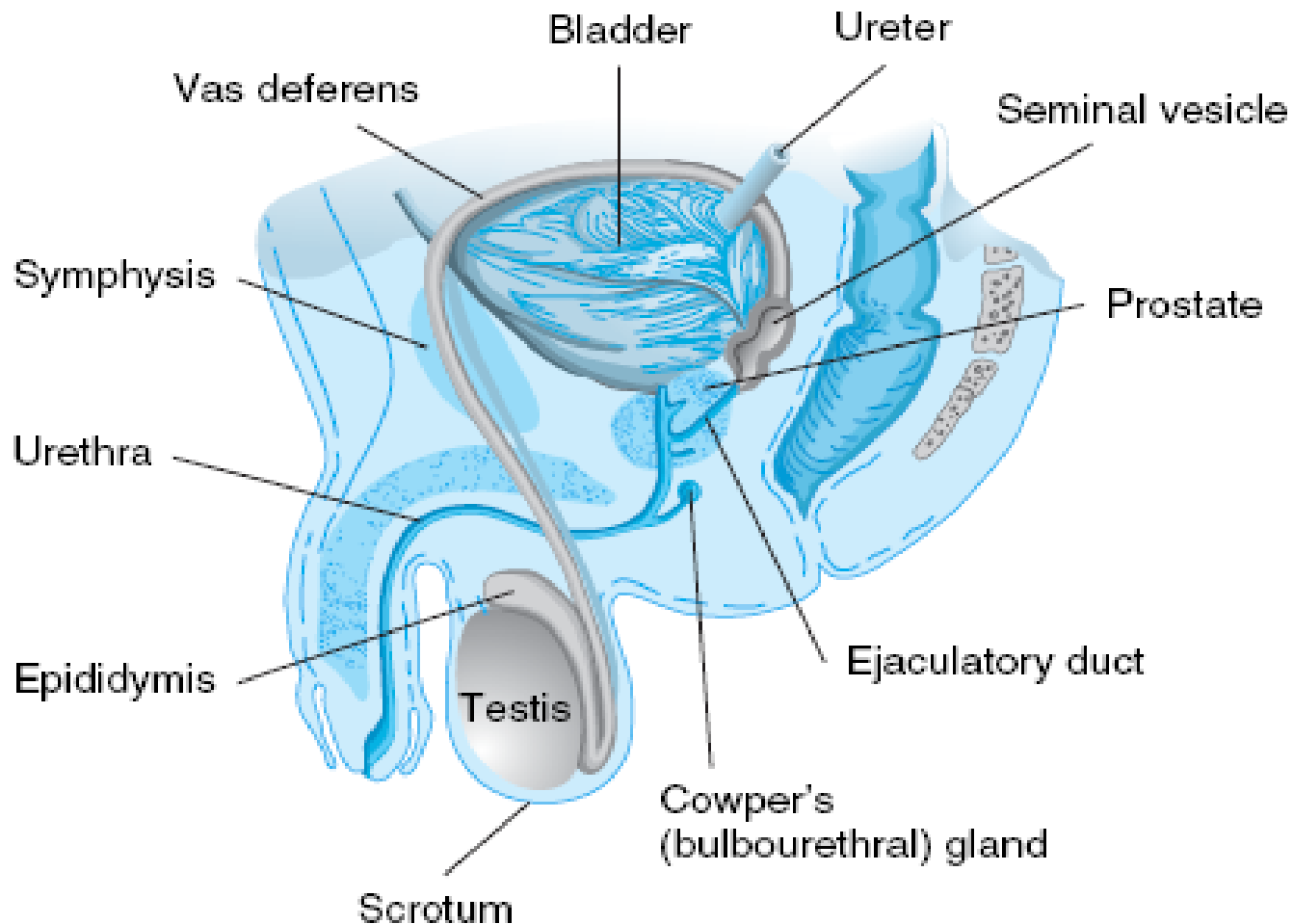
**Section 2**  
**Ovarian endocrine &  
female reproduction**

# Section 1

## Testis endocrine and male reproductive physiology

- ◆ Spermatogenesis: formation of sperm
- ◆ Endocrine functions of testis
- ◆ Regulation of testis function

# Male reproductive system

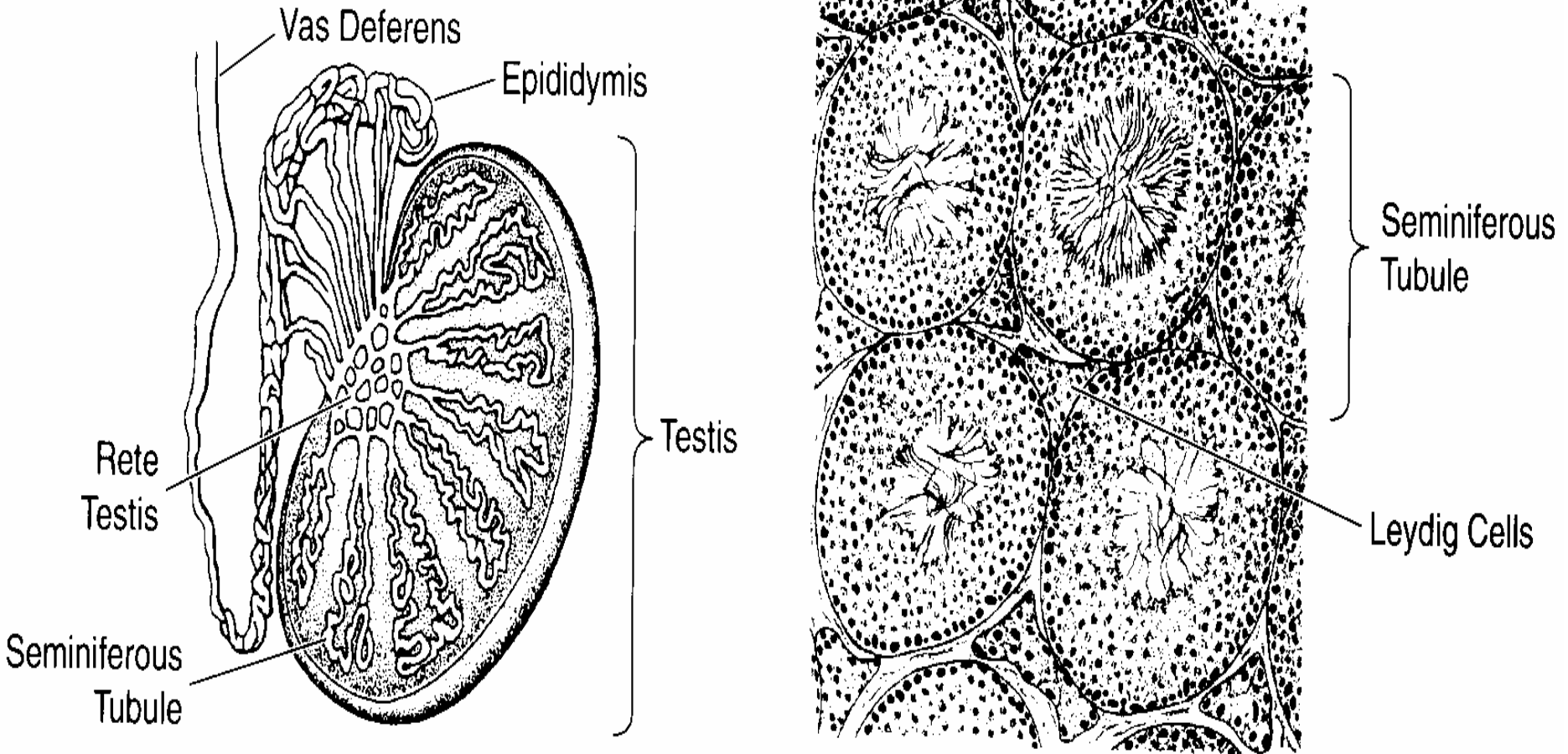


Male primary sex organ: Testis

## Spermatogenesis of Testis

1. The process of spermatogenesis
2. The transport of sperms and ejaculation

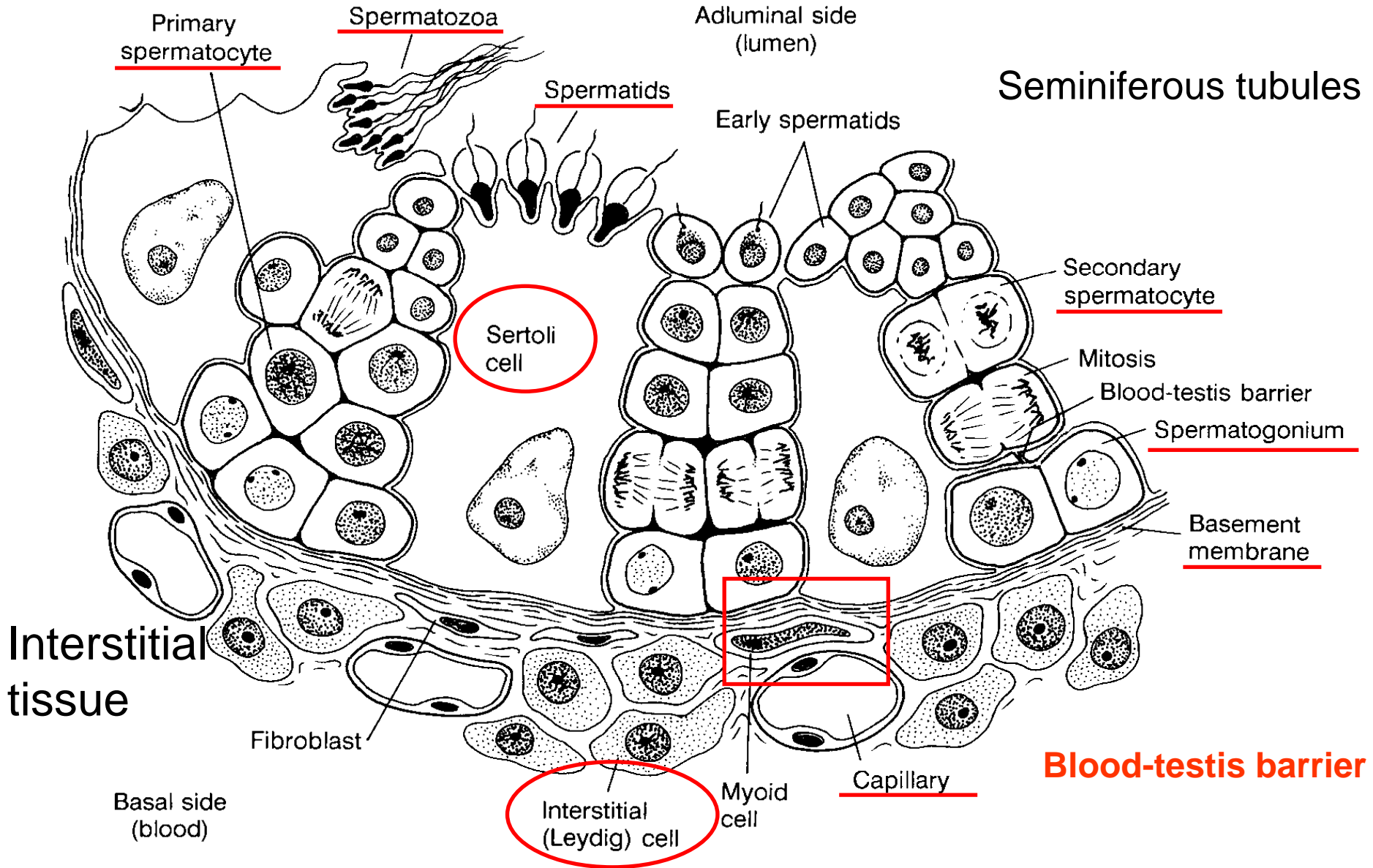
# Testis Anatomy



**Cross section of an area of testis**

# Spermatogenesis

# Sperm Production in the Testis





# Spermatozoa Structure and Functions in Review

- Head
  - Acrosome:
  - Nucleus:
- Midpiece
  - Centrioles:
  - Mitochondria:
- Tail: flagellum
  - Microtubules:

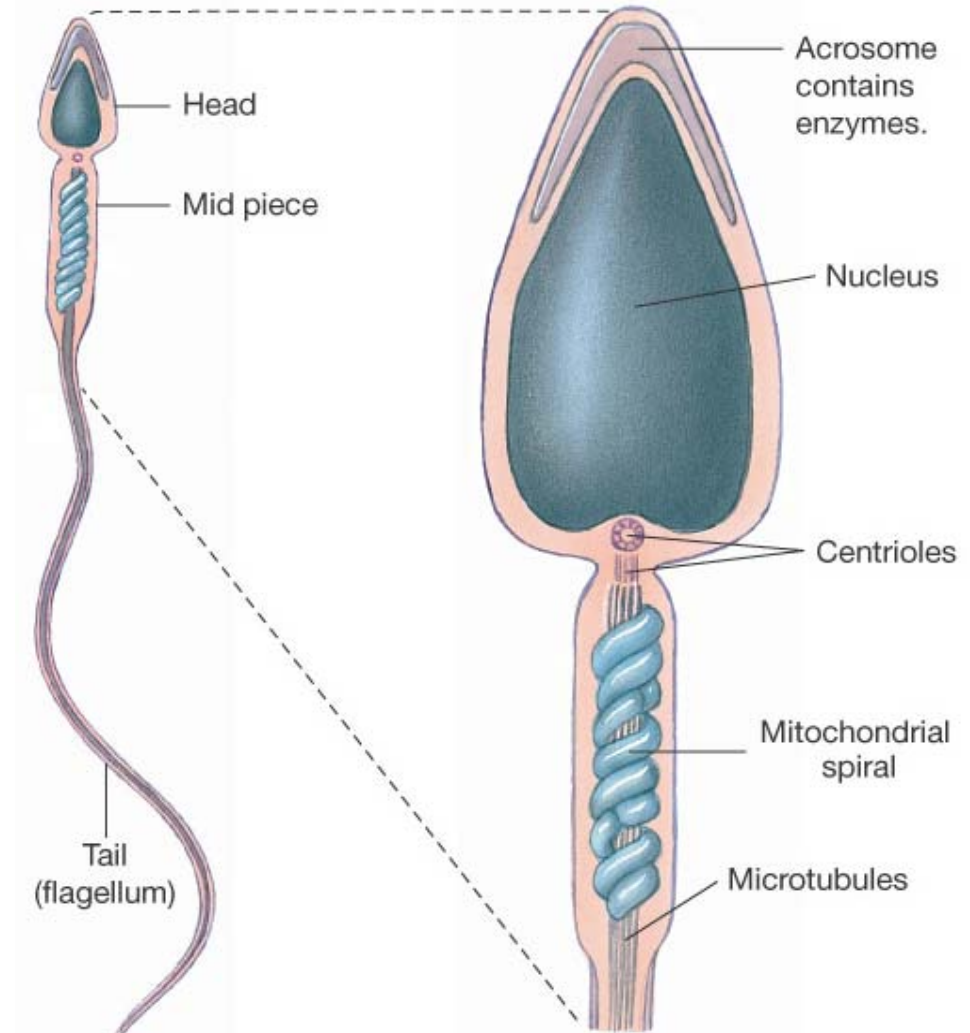


Figure 26-10: Sperm structure

- The **s**croto**m** normally maintains a temperature - 2°C lower than internal body temperature.
- The entire process of spermatogenesis takes approximately 64 days.
- The prostate gland and seminal vesicles secrete most of the fluid in which ejaculated sperms are suspended. The fluid, plus sperm cells, constitute semen (3~6ml, 20-100 million).

# Sertoli Cell Function

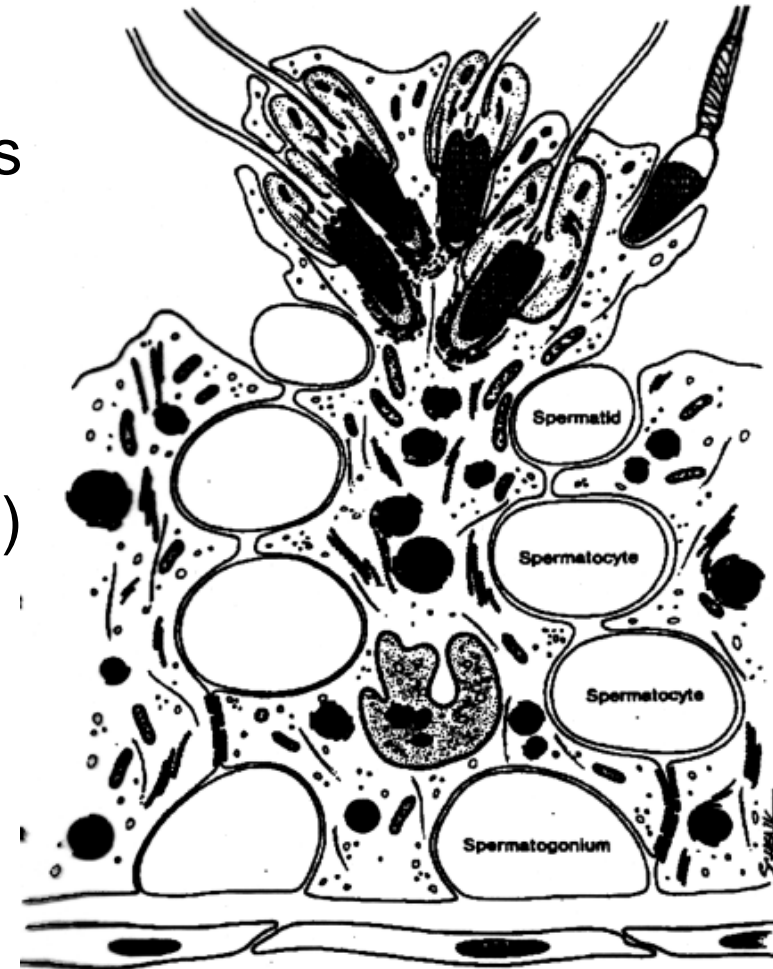
- Sertoli Cells

- Nourish healthy cells & phagocytize damaged germ cells
- Blood-testis barrier
- Secrete fluid & hormones
  - (1) inhibin,
  - (2) androgen-binding protein (ABP)

- Leydig cells (Interstitial cells)

- Secrete androgen

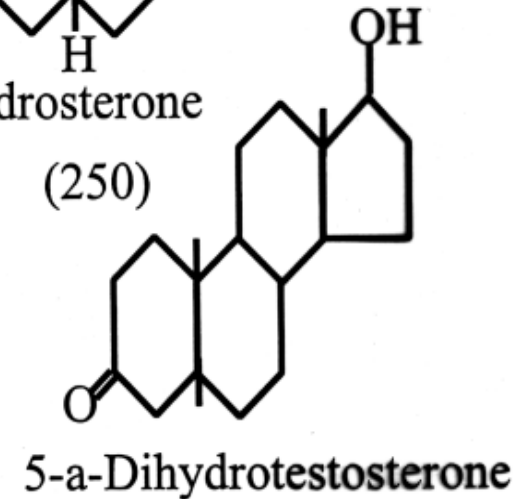
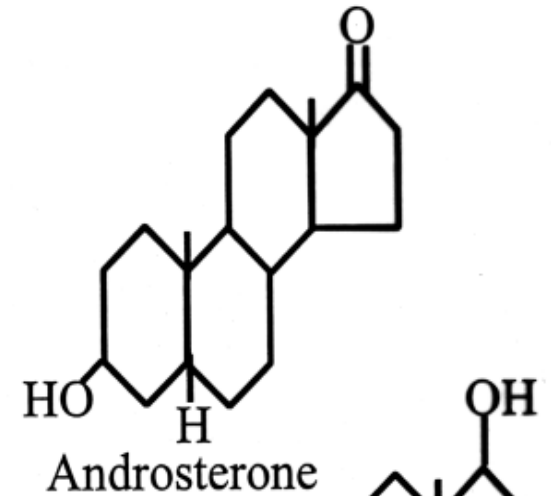
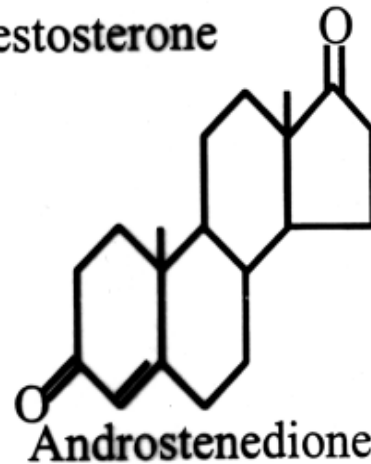
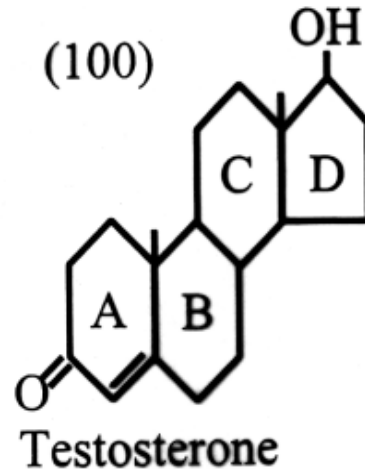
Association of Germ Cells with Sertoli Cells



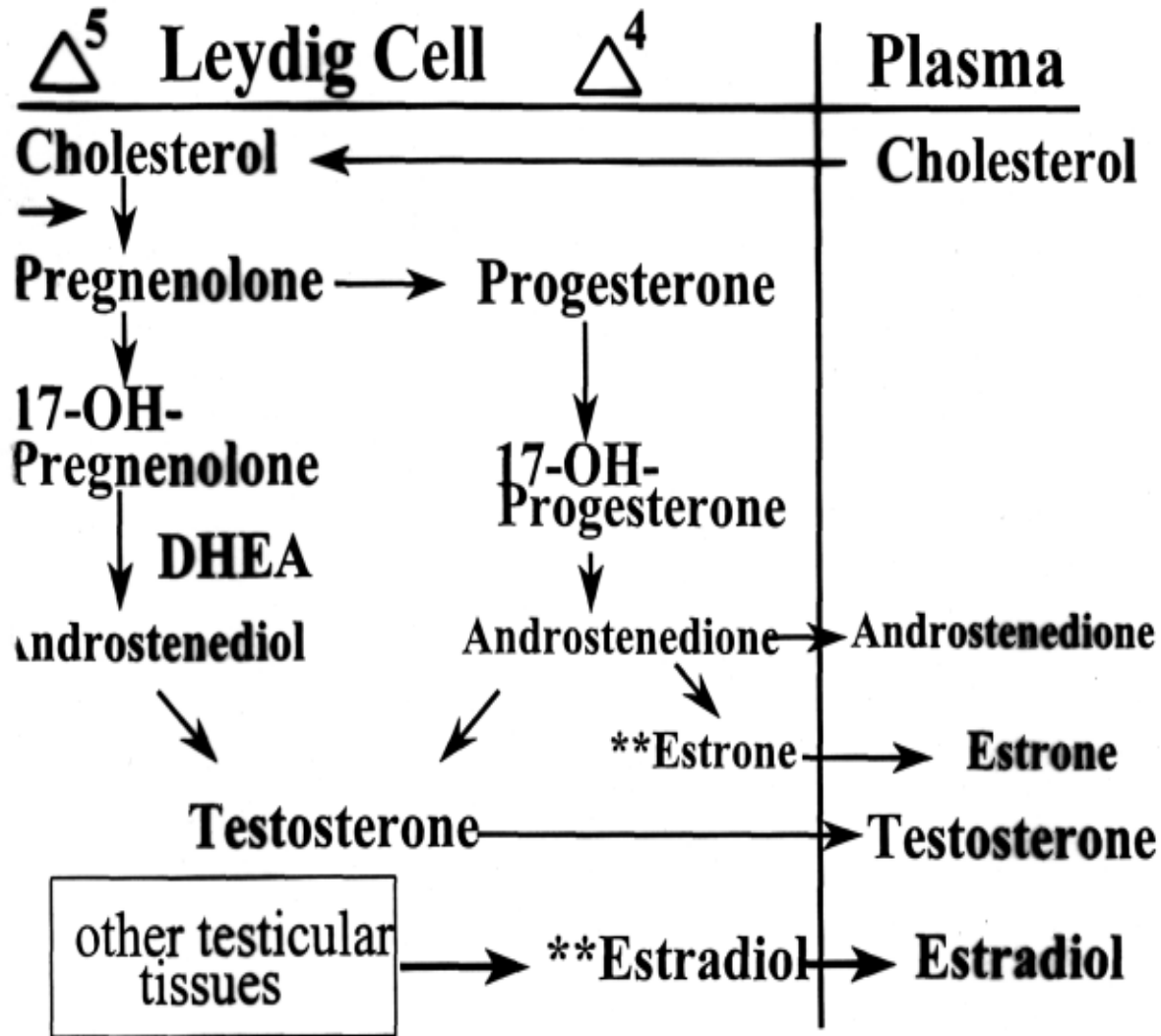
- The sperm-producing and testosterone-producing functions of the testes are carried out by different structures- the seminiferous tubules & Leydig cells, respectively.

# Major Testicular Steroids (Androgens)

- ( ) = Relative activity where T activity=100
- Androgens are C19 steroids
- Majority of 5  $\alpha$ -DHT is formed in peripheral tissues



# Male Sex Steroid Synthesis



Cholesterol may be from plasma or *de novo* synthesis

# Transport of Sex Steroids in Males

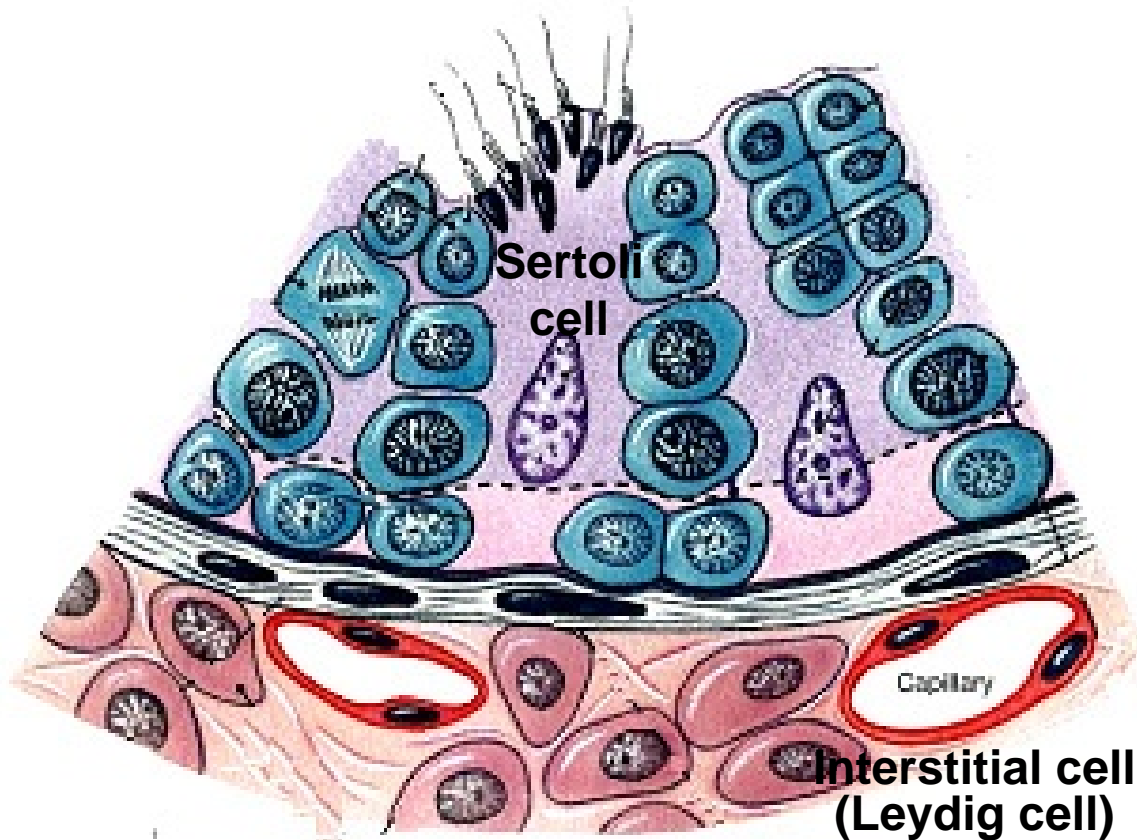
- Major Sex Steroid Binding Proteins
  - Testosterone-Estrogen (Sex hormone) Binding Protein
    - One high affinity binding site
    - Binding affinity order for sex steroids =
      - » **DHT (100) >T (33) >E (25)**
  - Albumin
    - One low affinity binding site
  - Cortisol Binding Globulin
    - No binding to DHT, T or E. Binds Progesterone
- Normal Distribution in Blood

TEBG (30%), Albumin (68%), Free (2%)

Active fraction includes free + albumin-bound fraction

# Androgen Activity

## 1. Maintain (not initiate) Spermatogenesis



- GnRH
  - LH
  - Leydig cells
  - testosterone
  - Sertoli cells
  - Dihydrotestosterone (DHT)
  - spermatocyte maturation



# Androgen Activity

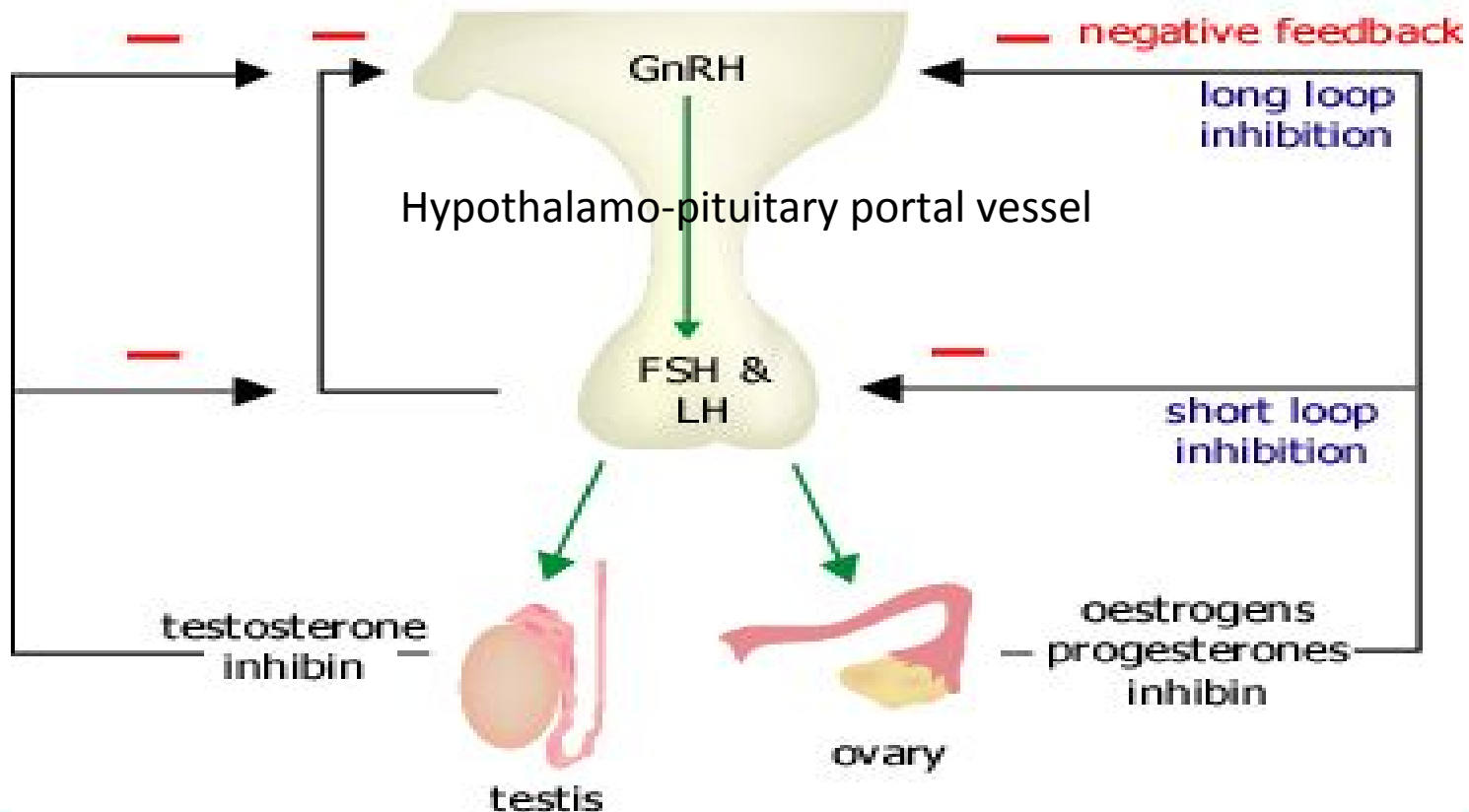
2. Stimulates the growth of reproductive organ, stimulates the development of secondary sexual characteristics, maintains sexual function
3. Promotes the synthesis of protein (muscle & reproductive organ), increase bone growth & erythropoiesis
4. Stimulates the embryo differentiation

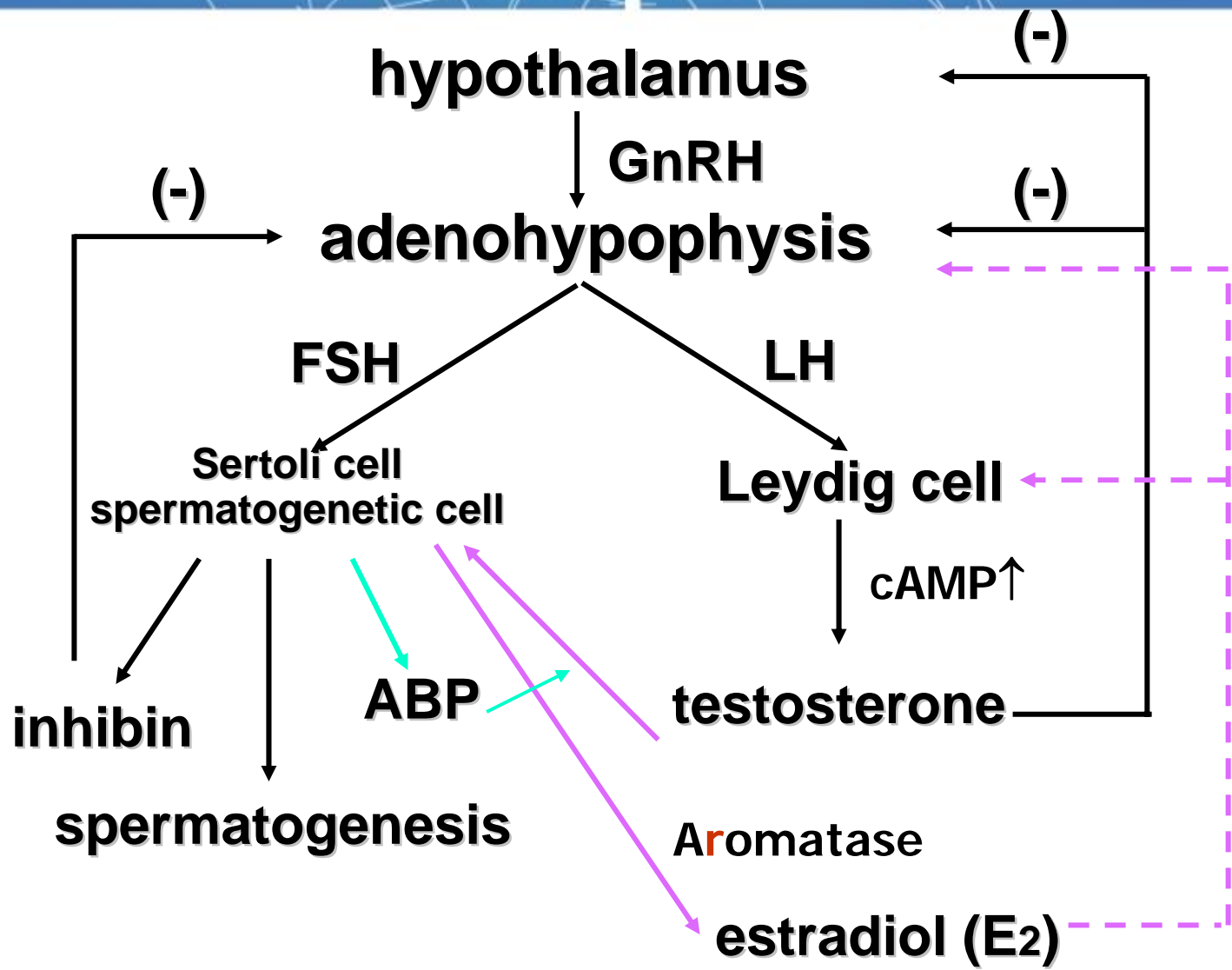
Increased atheletic performance

Increased basal metabolic rate, red blood cell density & oxygen utilization

# Regulation of testes functions

1. Control of testes functions by hypothalamus and pituitary
2. Feedback regulation of testes hormones





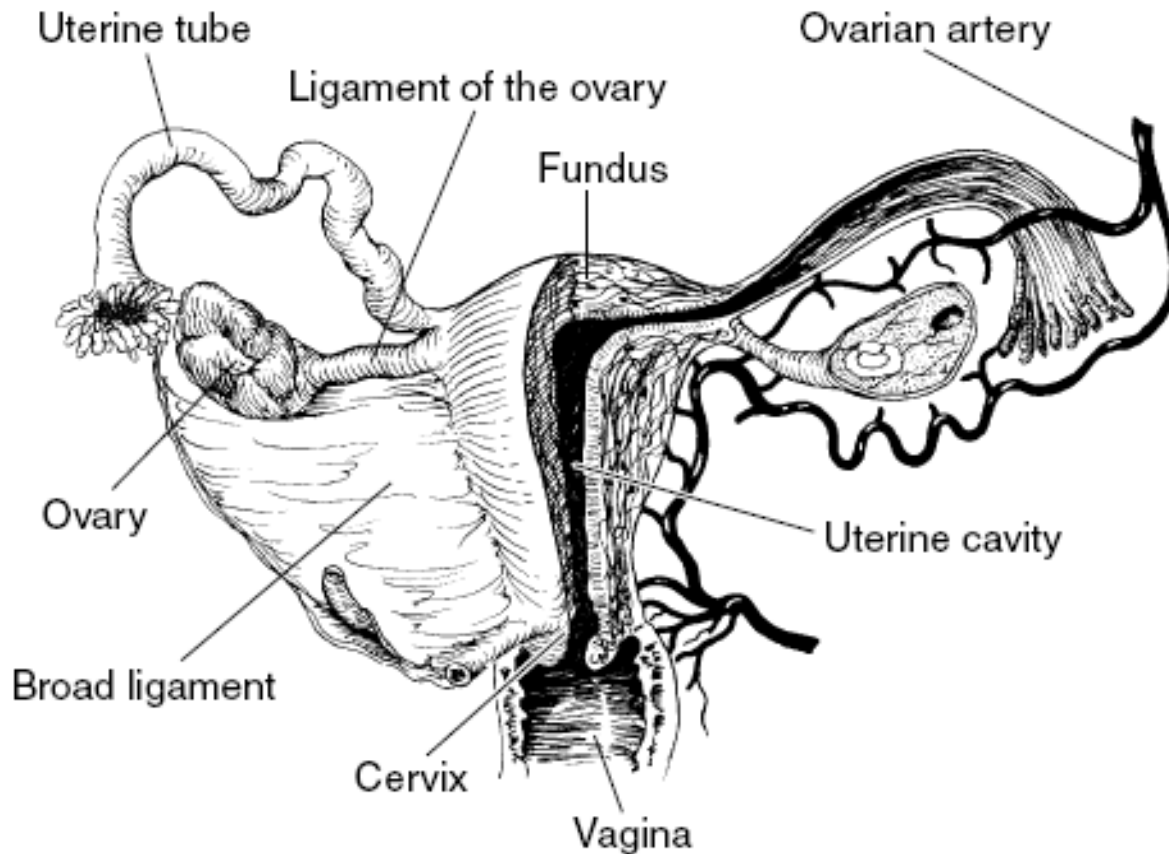
**ABP: androgen binding protein**

# **Section 2**

## **Female reproductive physiology**

- ◆ **Folliculogenesis : formation of follicle**
- ◆ **Endocrine functions of ovary**
- ◆ **Regulation of ovary function**

# Female reproductive system

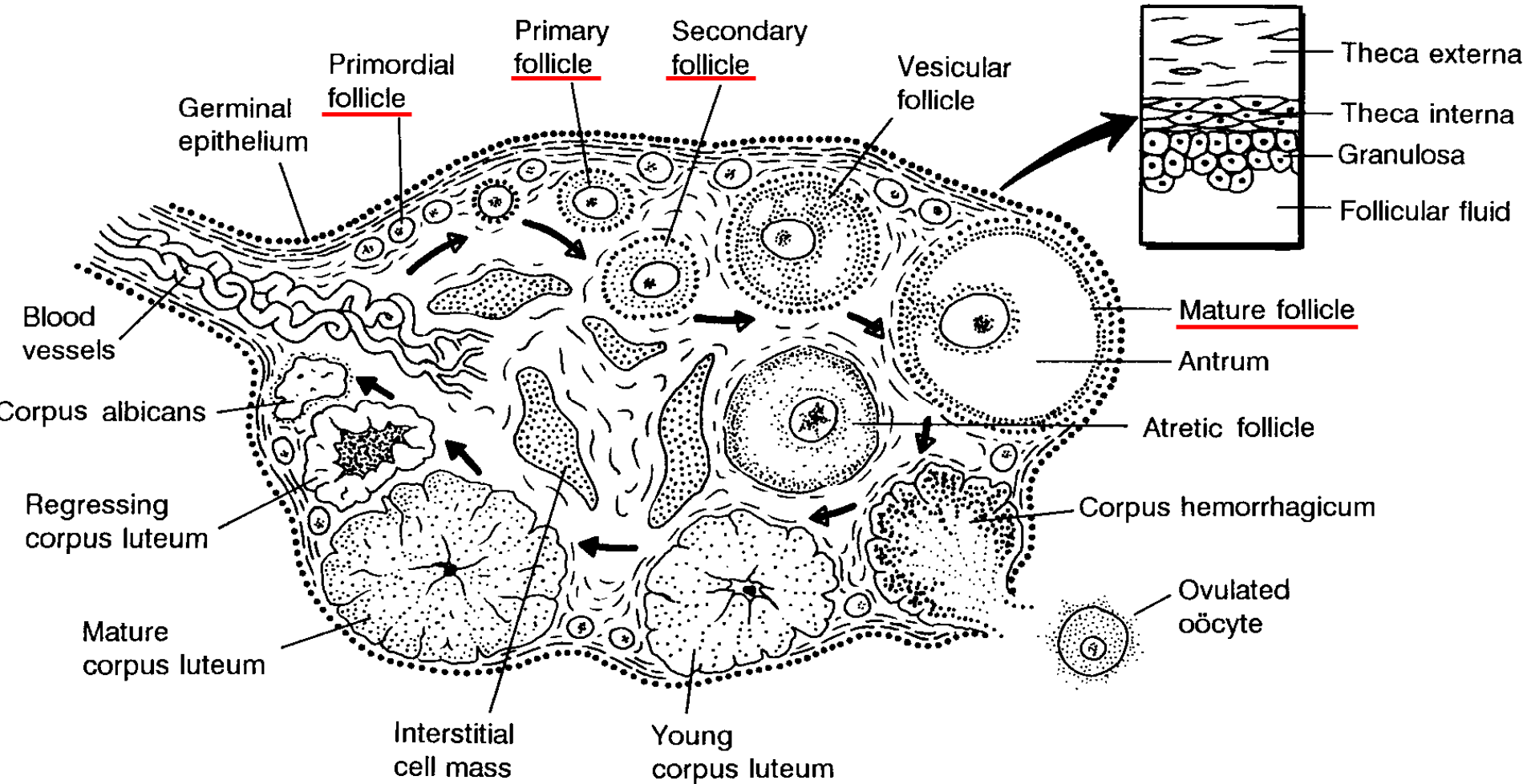


The structure & function of the uterus are synchronized with the ovarian cycles

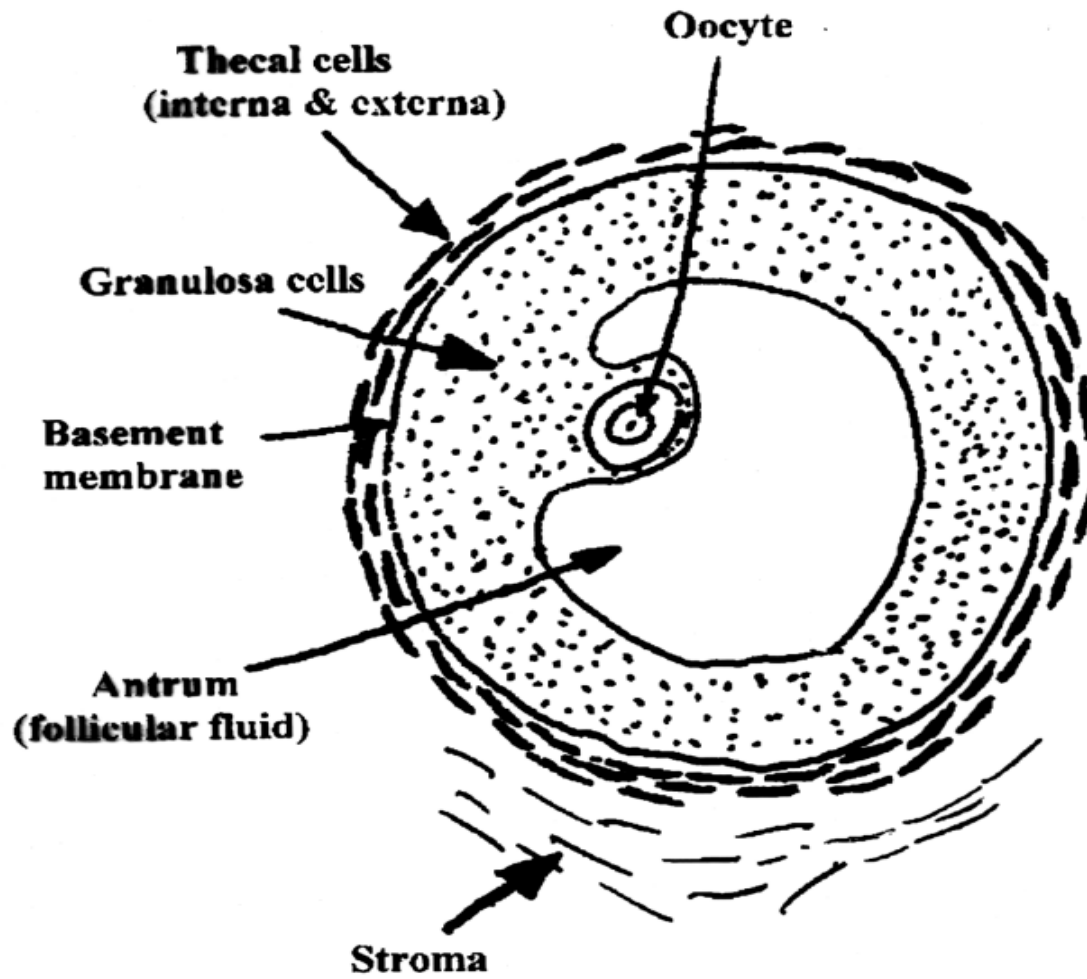
# Oogenesis of Ovaries

- 1. The process of follicle maturation**
- 2. Ovulation & formation of corpus luteum**

# Follicular maturation



# Follicular Structure



At birth: 2-4 million  
Puberty: less than 30000  
500 during a lifetime



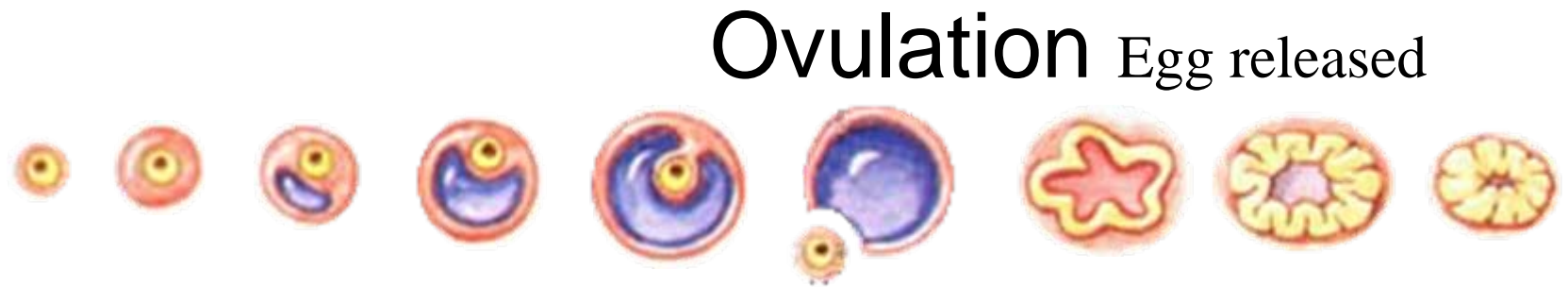
## Ovulation:

At about the 14<sup>th</sup> day of the cycle, the distended follicle ruptures, and the ovum is extruded in to the abdominal cavity. This is the process of ovulation

## Formation of corpus luteum:

- The follicle that ruptures at the time of ovulation promptly fills with blood, forming a **corpus hemorrhagicum**.
- The granulosa cells and theca cells of the follicle lining begin to proliferate, and the clotted blood is replaced with yellowish, lipid-rich **corpus luteum**.
- This eventually forms **corpus albicans** without pregnancy

# Ovarian Cycle



Follicular phase

Egg matures

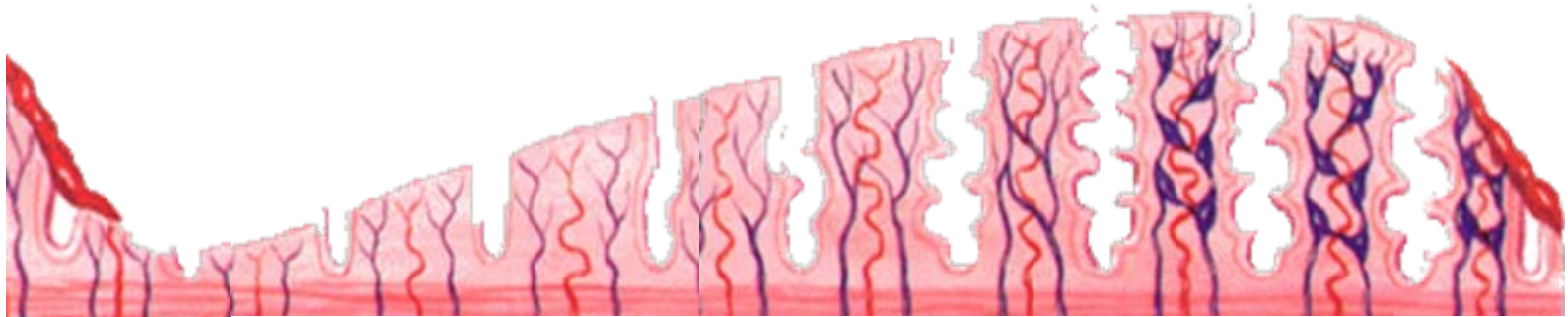
Luteal phase

# Uterine (Menstrual) cycle

Endometrium changes

Menstrual  
Phase Endometrium degenerate

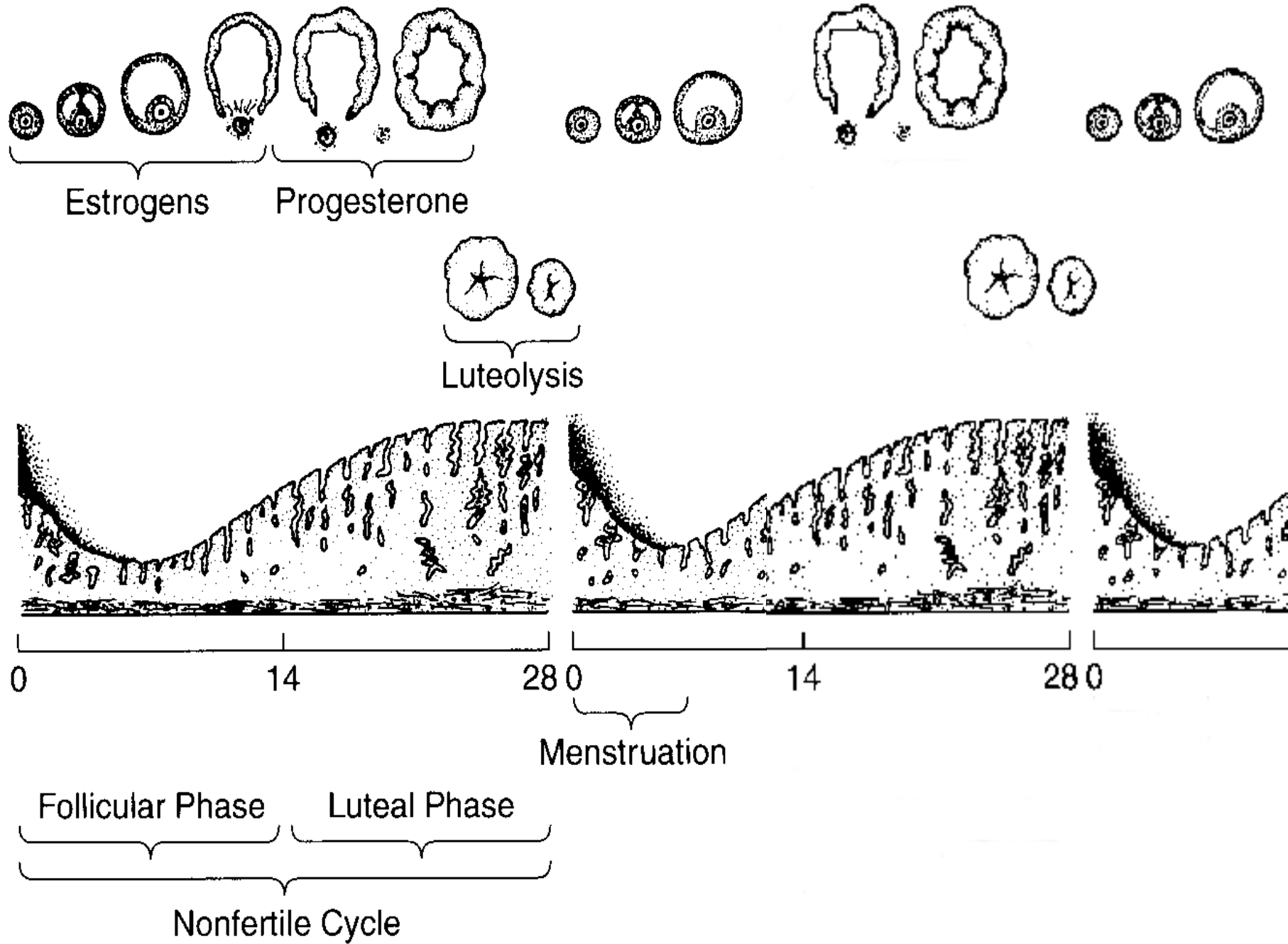
Menstrual  
phase



Proliferative phase  
Regenerate

Secretory phase  
Prep for blastocyst

Endometrium: highly vascularized, slightly edematous  
Glands: coiled & tortuous



# **Endocrinal function of ovaries**

**(estrogen, progesterone, inhibin, androgen)**

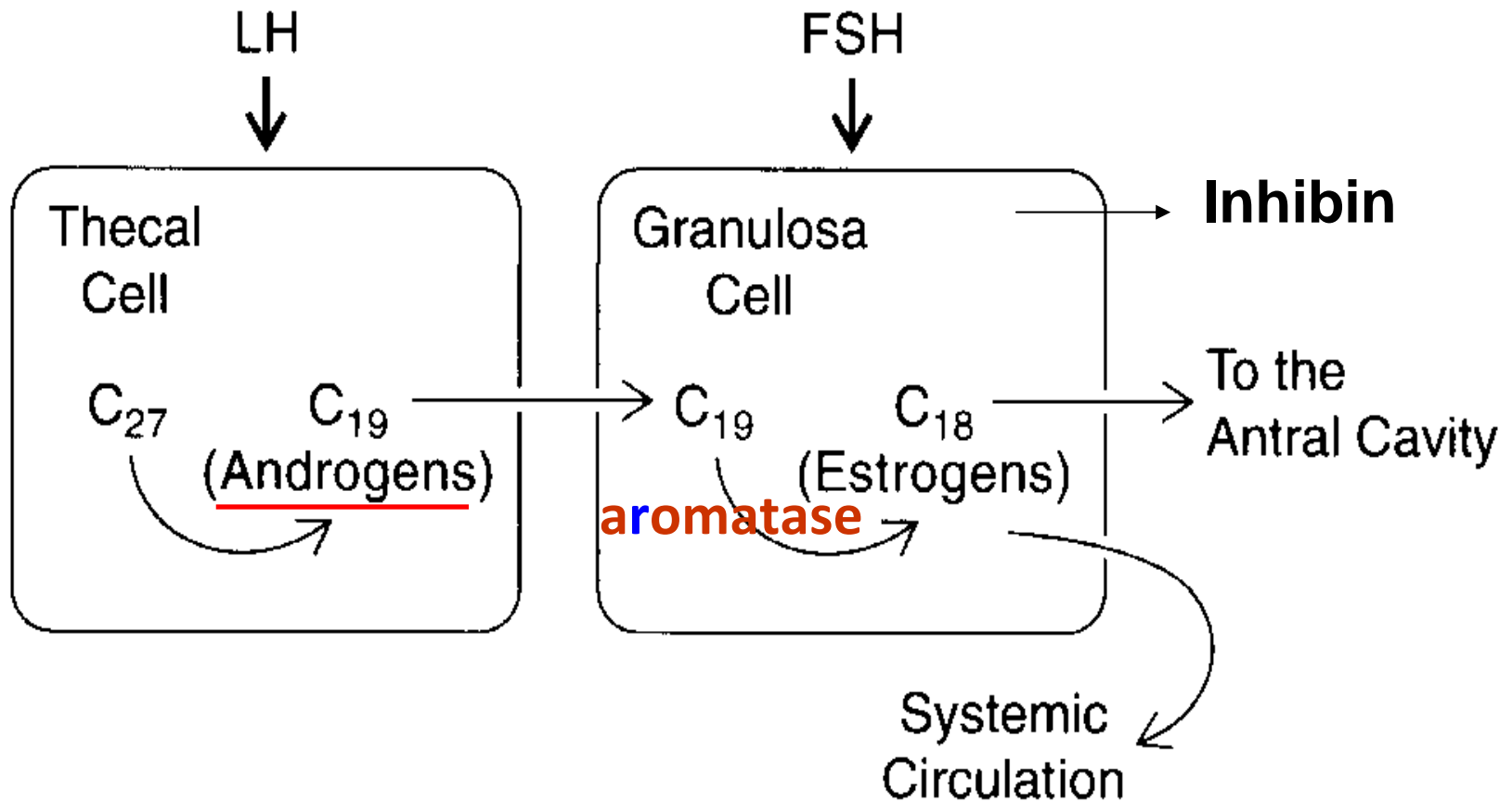
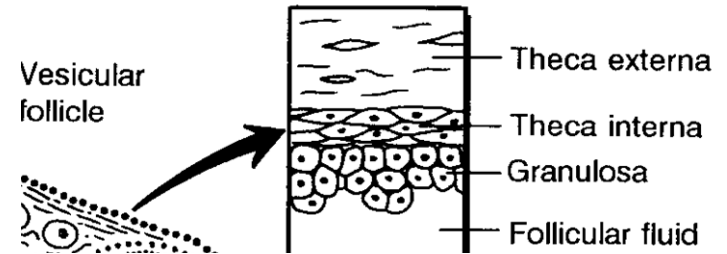
**Follicular phase: granulosa cells & theca cells**

**Estrogen, small amounts of progesterone, inhibin**

**Luteal phase: luteal cells**

**Estrogen, progesterone, inhibin**

# Two cell-two gonadotropin scheme



# Physiological effects of estrogen

Estradiol (main), estrone, estriol

- \* **Development of female reproductive organs**

Uterine tube、 Uterus 、 Vagina

- \* **Development the breast and secondary characteristics**

- \* **Effect on metabolism: bone, kidney, brain**  
aldosterone

# Menopausal symptoms

- Hot flash, depression, mood swings, sleeping disorders
- Vaginal dryness
- Osteoporosis, cardiovascular disease, neurodegenerative diseases





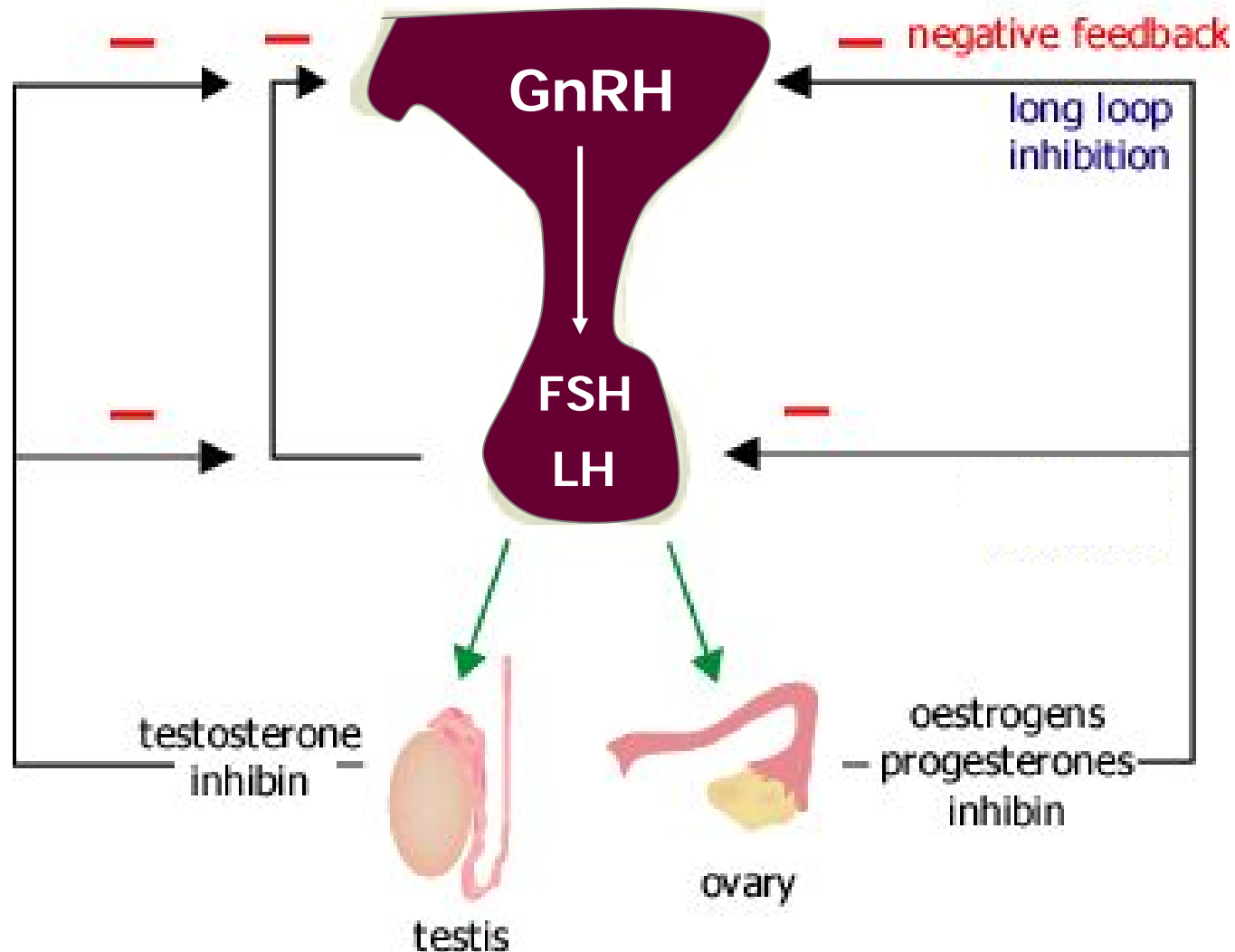
# **Physiological effects of progesterone**

## **On the basis of estrogen**

- \* Uterus: implantation & pregnancy**
- \* Effect on the breast**
- \* Increase basal body temperature**

# Regulation of Ovary function

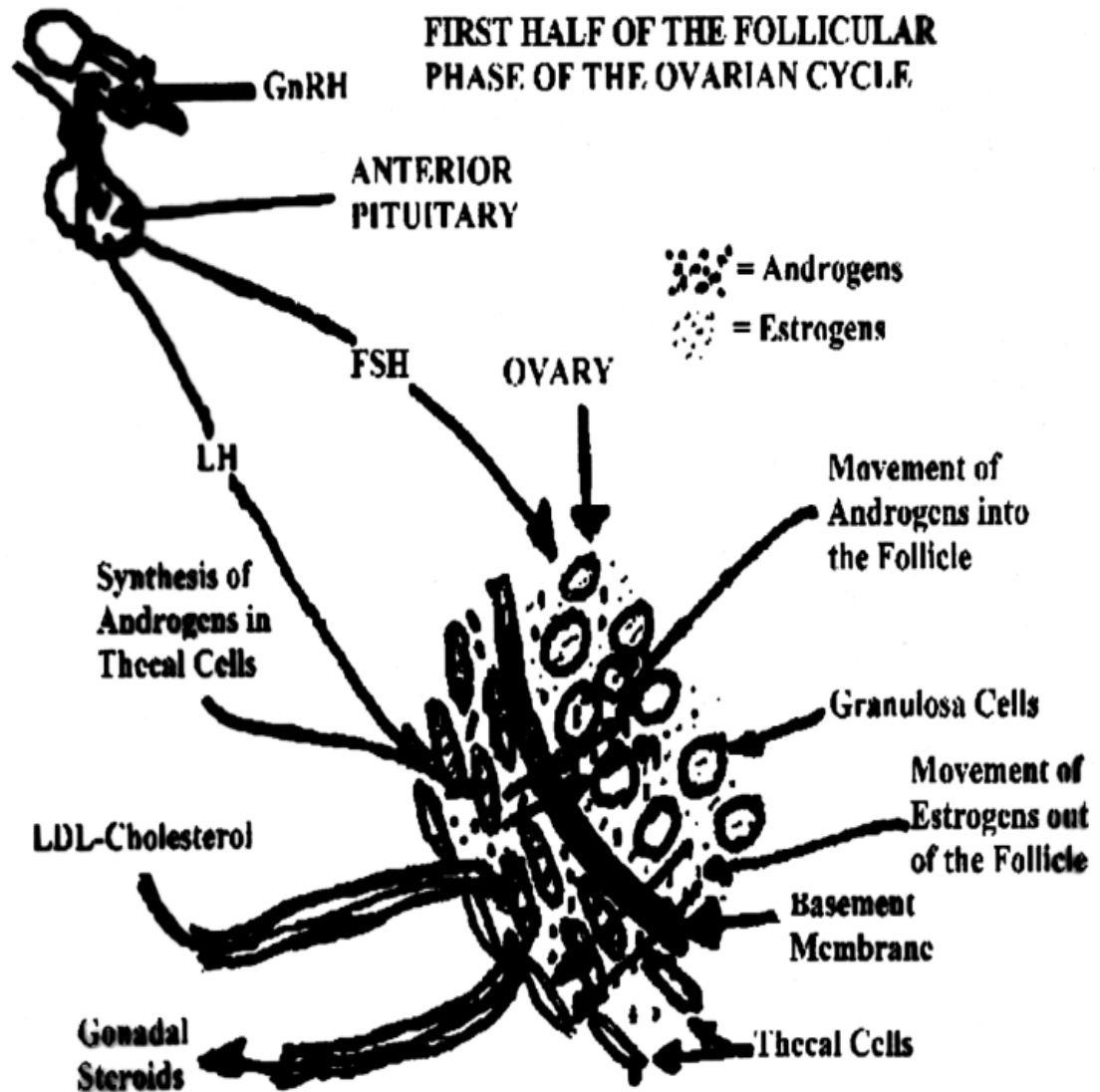
## Hypothalamic-Pituitary-Ovary Axis



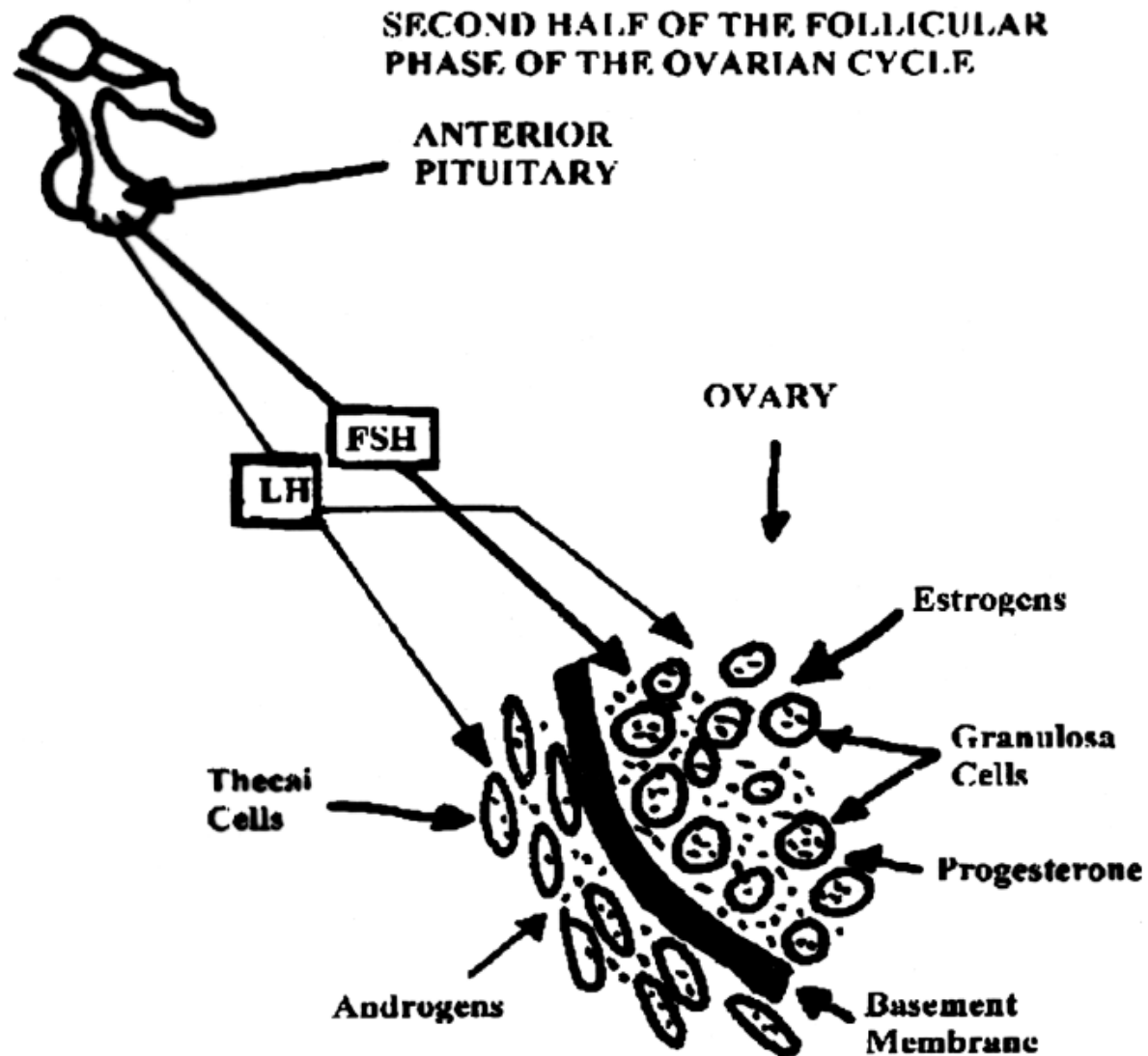


# Endocrine Control of ovary Cycle: Follicular Phase

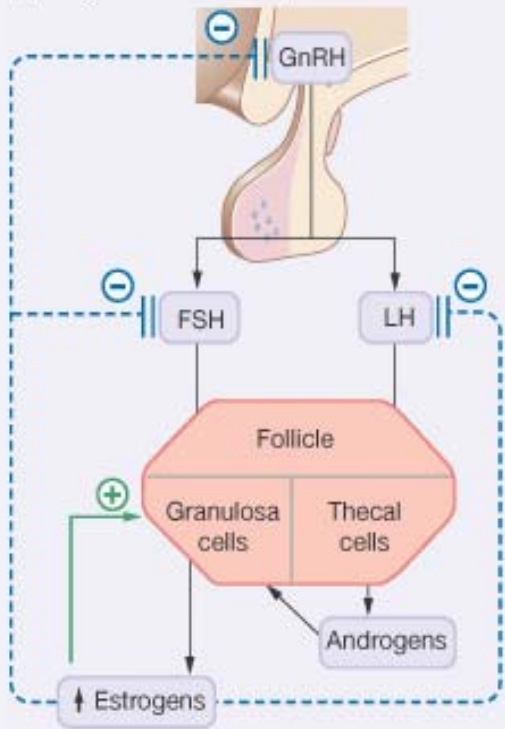
- GnRH rises in response to a decline in sex steroids
- GnRH stimulates rise in pituitary FSH & LH secretion.
- FSH stimulates new follicle growth
- LH induces thecal cell growth, vascularization & androgen synthesis



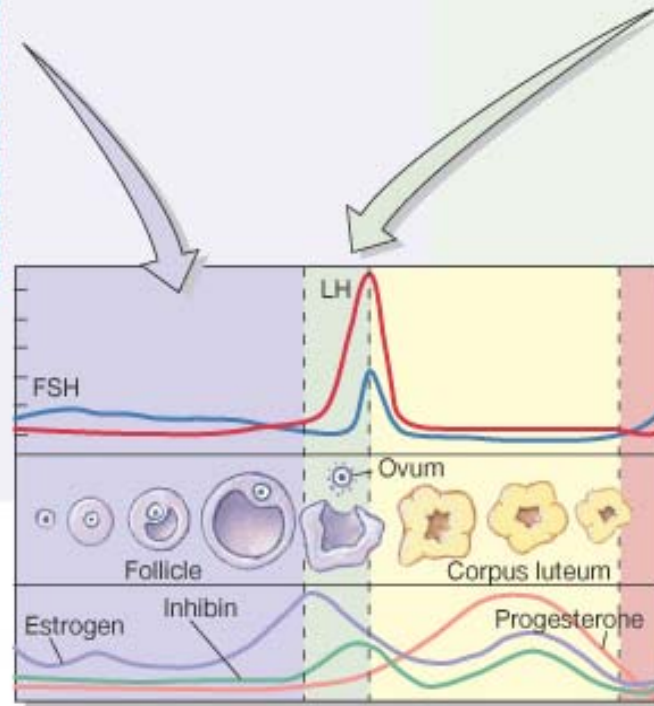
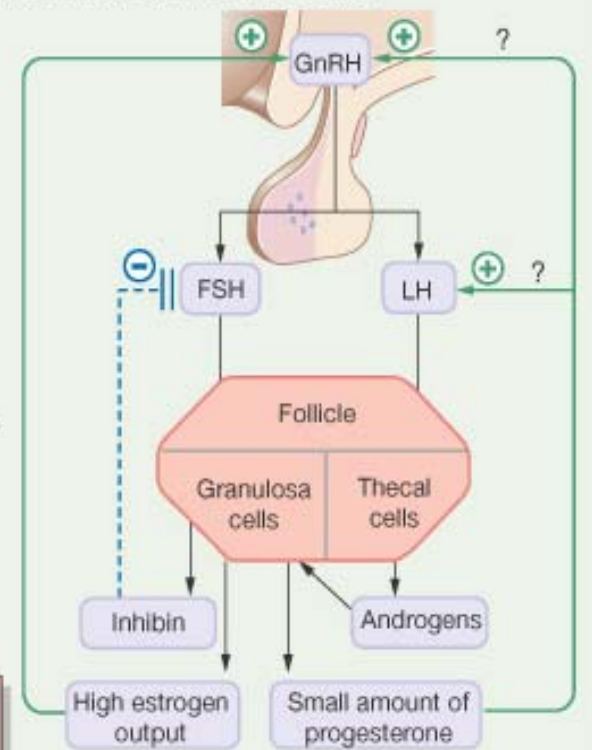
- LH act on thecal cells and FSH acts on granulosa cells, E produced.
- Inhibin  $\uparrow$  pushes FSH down,  $\downarrow$  new follicle development
- E+ feedback
- Estrogen  $\uparrow$   $\rightarrow$  LH "surge" & FSH spike  $\rightarrow$  egg release



(a) Early to mid-follicular phase

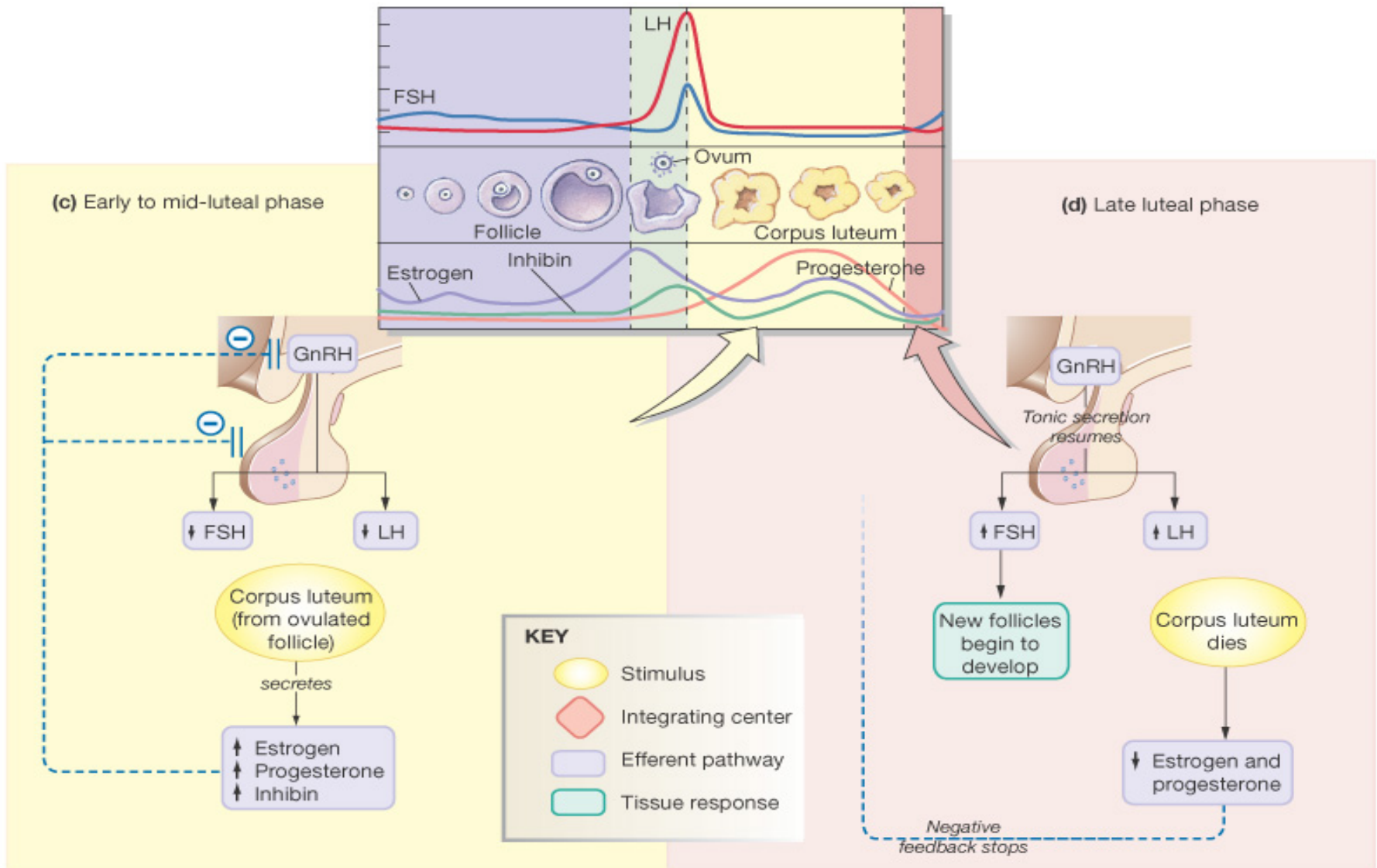


(b) Late follicular phase and ovulation



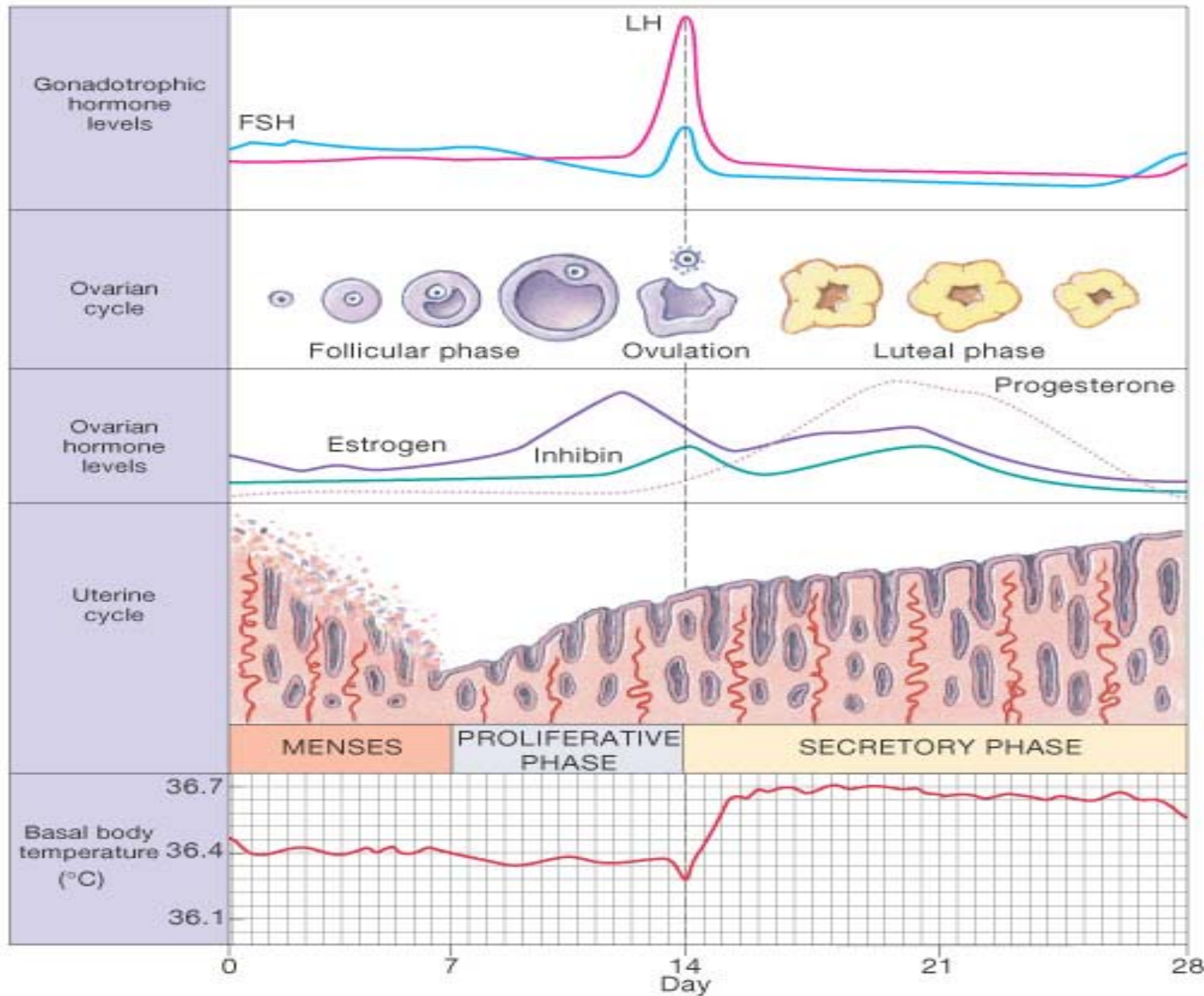
# Endocrine Control of Menstrual Cycle: Luteal phase

- Granulosa cells form corpus luteum → progesterone
- progesterone & estrogen ↑ maintain endometrium
- Inhibin continues to limit new follicular development
- Pregnancy: progesterone, estrogen ↑
- No pregnancy: progesterone, estrogen & inhibin ↓
  - Menses, ↑ FSH & LH → new follicle development





# Overview of the Menstrual Cycle



# Placenta and Further Embryonic Development

**(a)** The developing embryo floats in amniotic fluid. It obtains oxygen and nutrients from the mother through the placenta and umbilical cord.

**(b)** Some material is exchanged across placental membranes by diffusion, but other material must be transported.

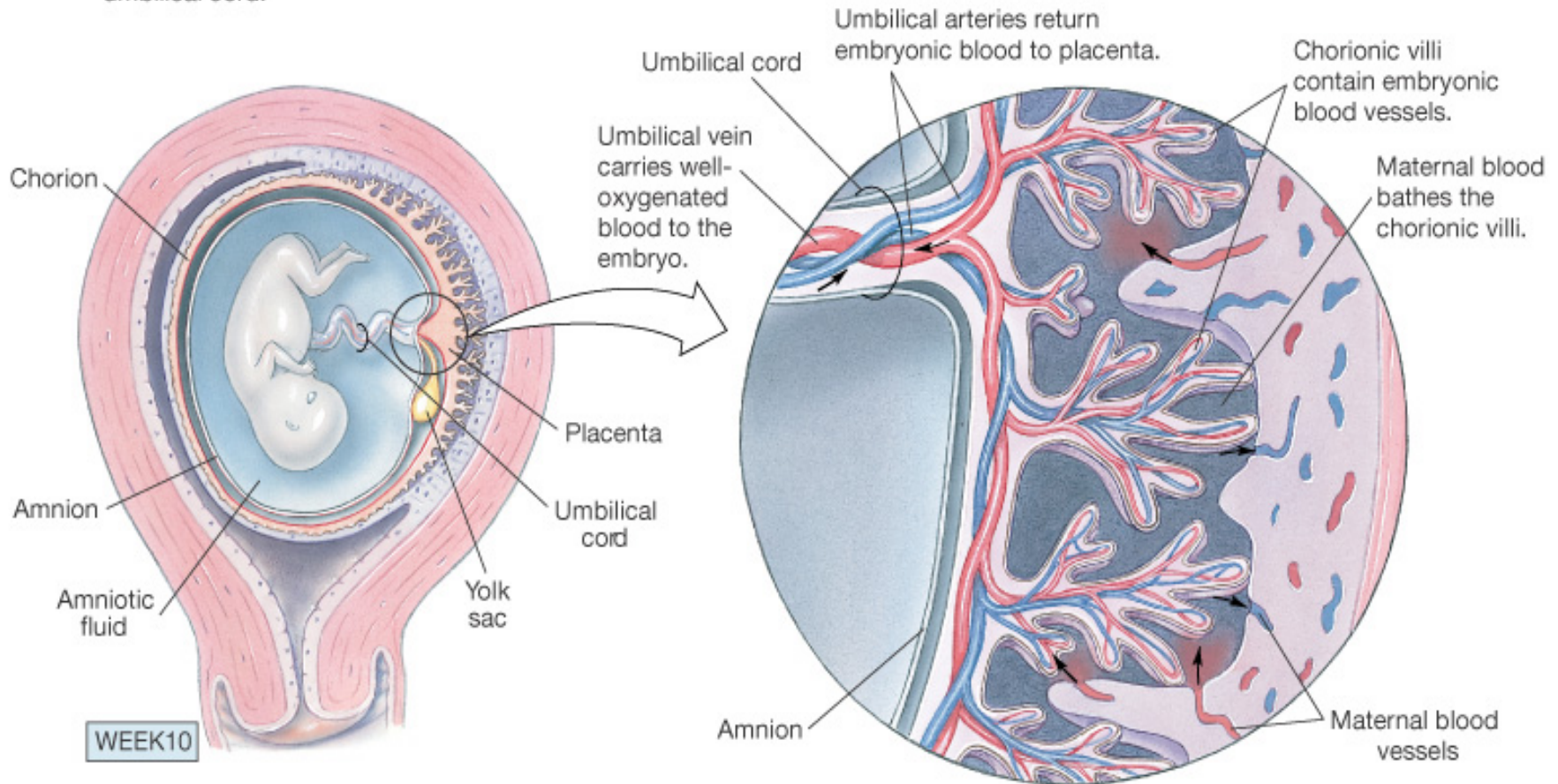


Figure 26- 19a, b: The placenta

# Birth: Parturition

- Labor (initiated by a fetal signal)
  - Rhythmic (stretch induces release of oxytocin)
  - Uterine (oxytocin continues uterine contractions)
  - Contractions
  - Cervical dilation (induced by relaxin)
- Delivery
  - Baby
  - Placenta

# Birth: Parturition

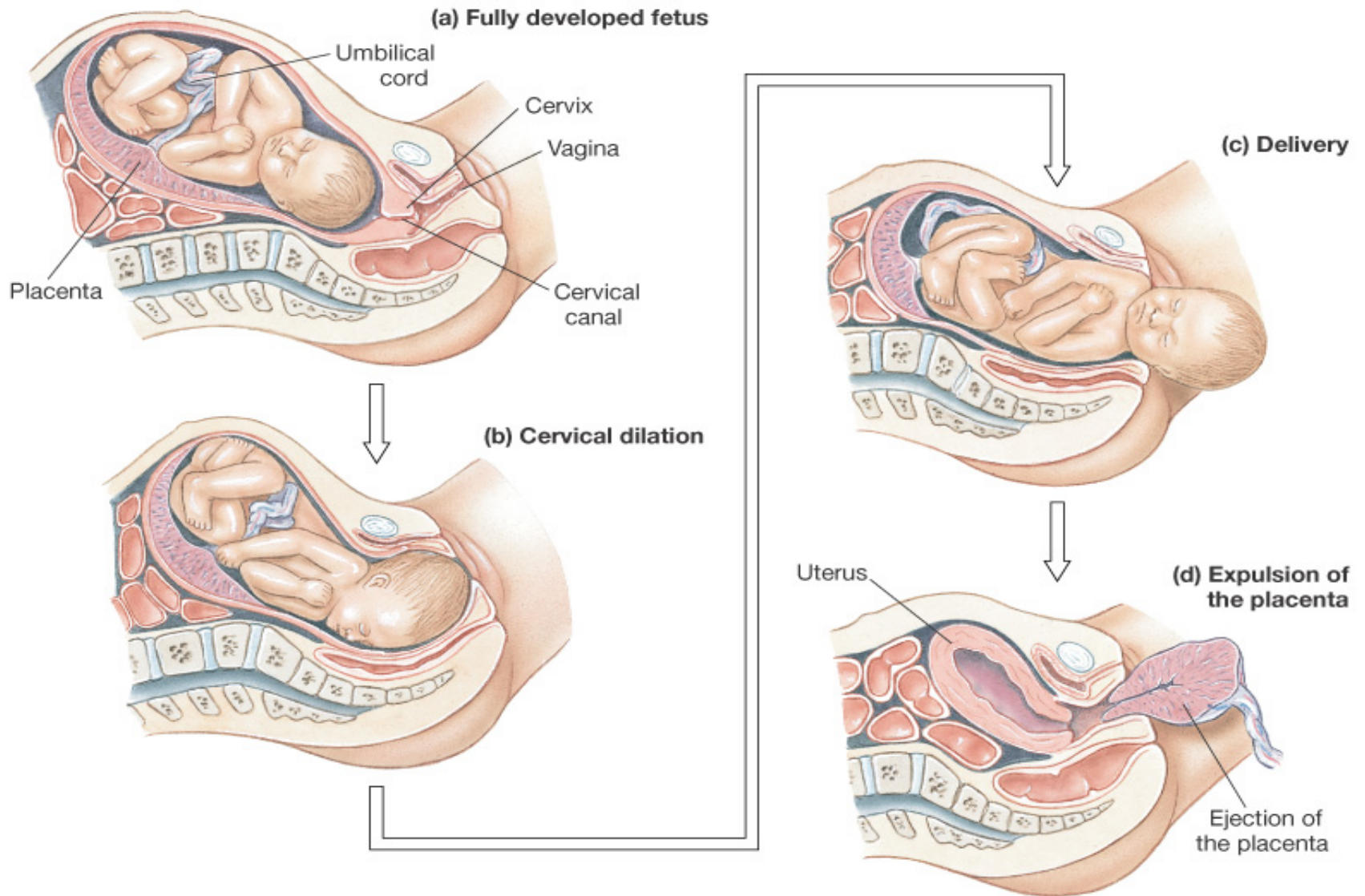


Figure 26-20: Parturition: the birth process

# Regulators of Parturition

- Labor onset
- Stretch stimulus
- Oxytocin
- Prostaglandins
- Positive feedback
  - ↑ Stretch →
  - ↑ Oxytocin
  - Birth ends

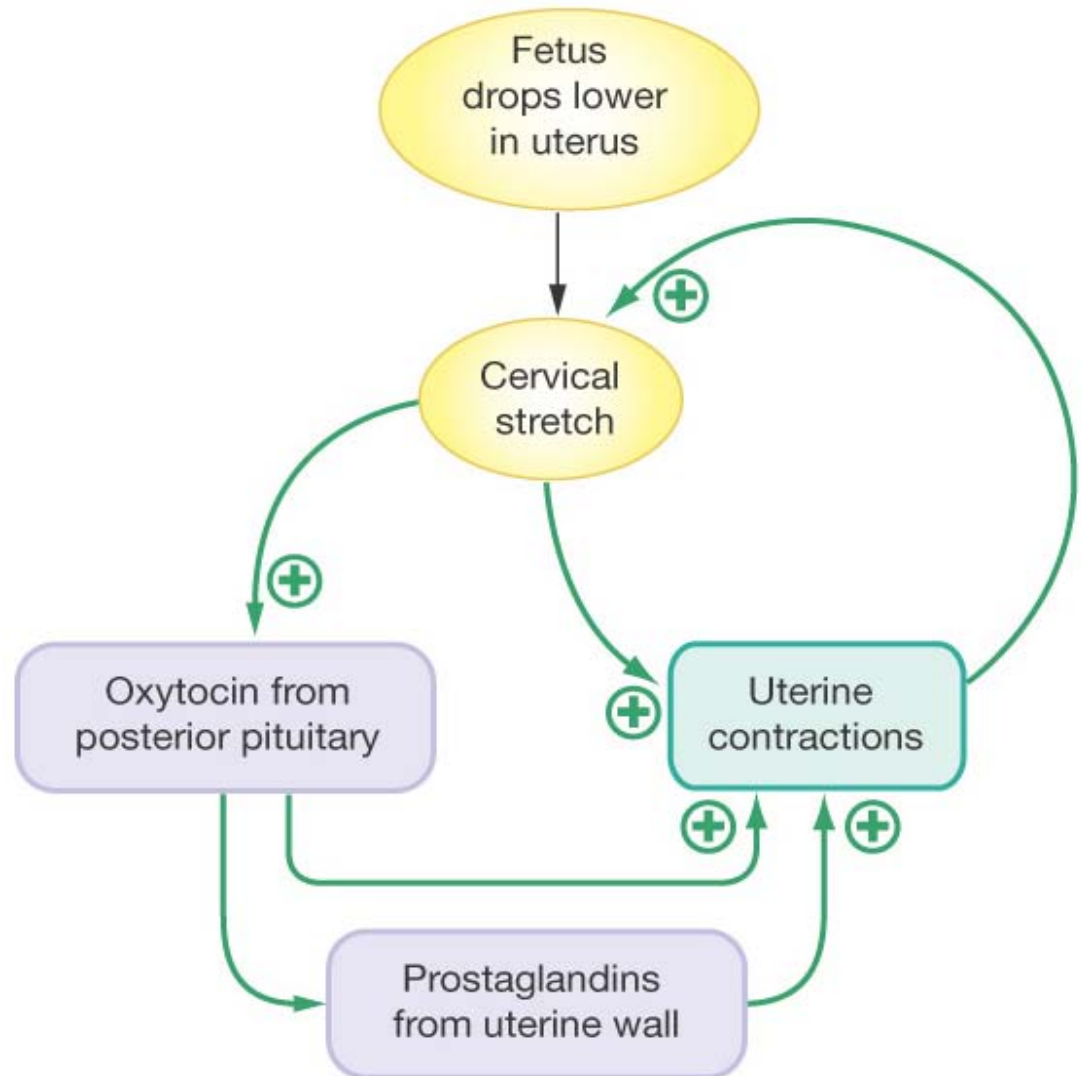


Figure 26-21: The positive feedback loop of parturition 45

# Reproductive Maturation: Puberty

- Increase production of sex hormones
- Maturation of reproductive organs & gamete production
- 2<sup>o</sup> sexual characteristics
  - Males: pubic hair, beard, deep voice, "wedge" body form & ↑ muscle mass
  - Females: menarche, pubic hair, breasts & "pear shape" body form

# Later in Life

- Menopause: Female "Change-of Life"
  - Ovaries responding to GnRH ↓
  - Levels of estrogen & progesterone produced ↓
  - Cease egg development
  - "Hot flashes" , osteoporosis risk ↑
- "Andropause" (?): Male changes are gradual
  - Testes responding to GnRH ↓
  - Sex hormones ↓ : muscle mass, libido, erections ↓

# Chapter 12 Review question

- Describe the sertoli cells functions
- Define the different phases in ovary cycle and corresponding menstrual cycle.
- Describe the endocrine control of follicular phase
- Describe the endocrine control of luteal phase