Zoology , Endocrinology (404)

By Dr Sadhana Shrivastava

Spermatogenesis

Reference books-

Endocrinology of the male reproductive system and spermatogenesis- Liza O'Donnell, Peter Stanton, David Morritz de Kretser

Handbook of Physiology Section 7 Endocrinology Volume V Male Reproductive System-R O Astwood, E B Greep

Spermatogenesis

Introduction :

Spermatogenesis is the process by which haploid spermatozoa develop from germ cells in the seminiferous tubules of the testis. This process starts with the mitotic division of the stem cells located close to the basement membrane of the tubules. Meiosis is a step during **spermatogenesis** and **oogenesis**.

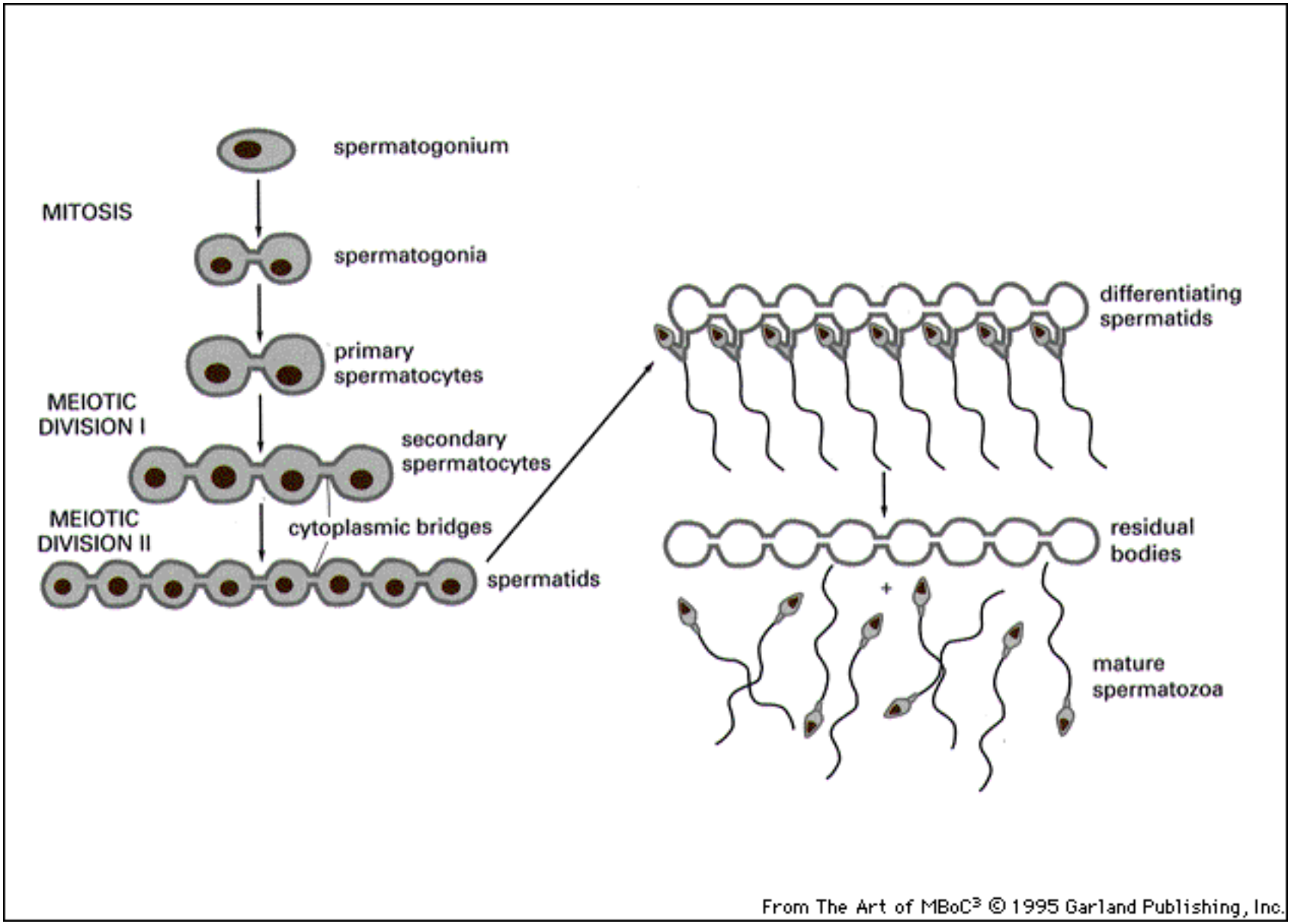
Spermatogenesis produces four haploid **sperm** cells, while **oogenesis produces** one mature ovum.

Two haploid spermatids (haploid cells) are generated by each secondary spermatocyte, resulting in a total of four spermatids. Spermiogenesis is the final stage of **spermatogenesis**, and, during this phase, spermatids mature into spermatozoa (sperm cells)

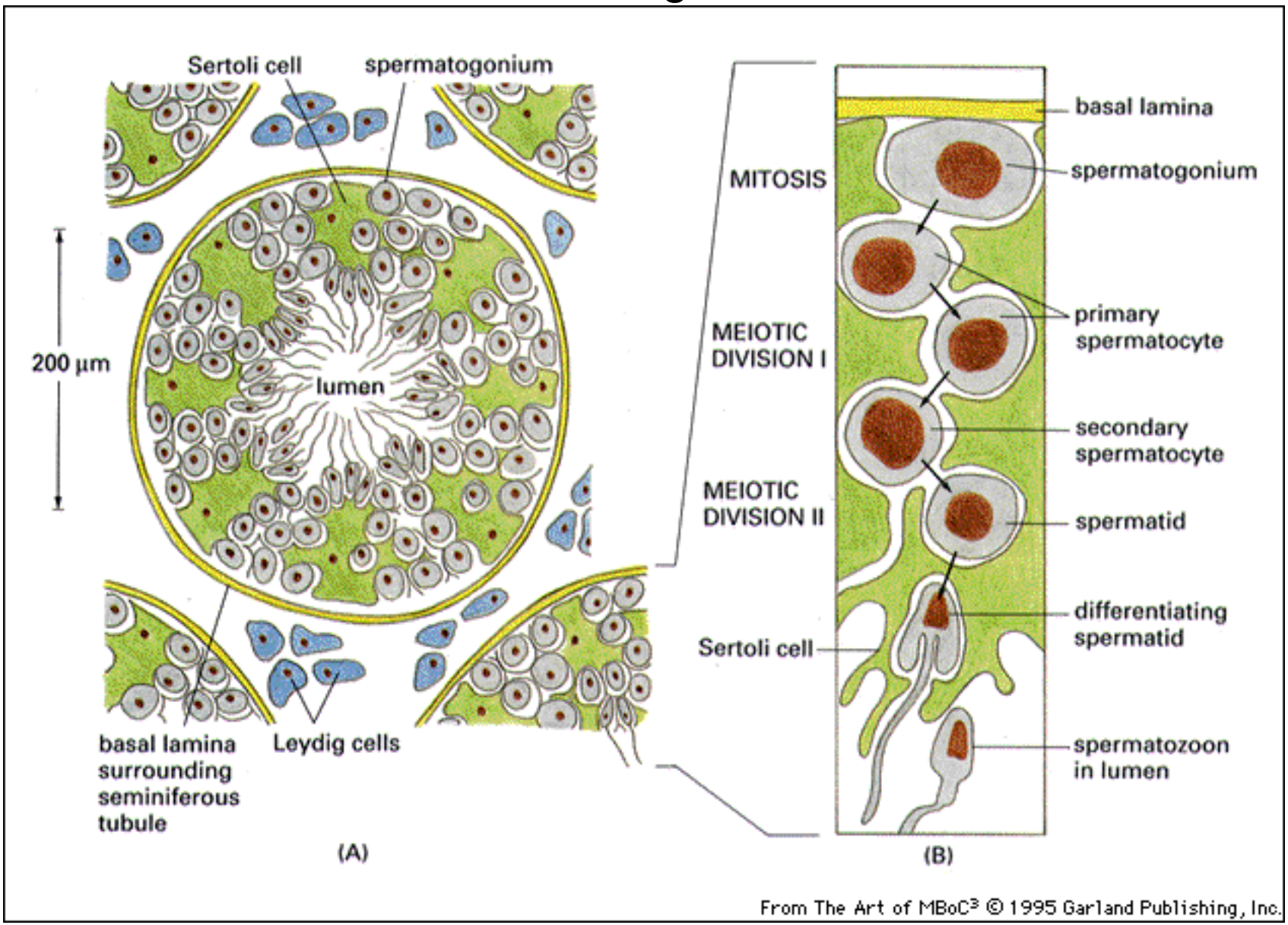
The **seminiferous tubules**, in which the sperm are produced, constitute about 90 percent of the testicular… The immature cells (called spermatogonia) are all derived from cells called stem cells in the outer wall of the **seminiferous tubules**.

The process of producing mature sperm is called spermatogenesis. Sperm are produced in the seminiferous tubules of the testes and become mature in the **epididymis**. The entire process takes about 9 to 10 weeks.

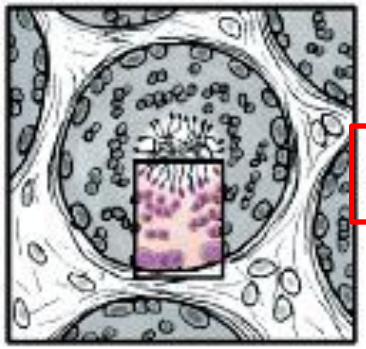
Spermatogenesis



Cross section through seminiferous tubule



Cross section of seminiferous tubules



Spermiogenesis

Spermatozoa

Spermatids

Secondary spermatocytes

Primary spermatocyte

Sustentacular cell nucleus

Type B spermatogonia

Blood-testis barrier

Sustentacular cells

Basement membrane

Lumen

Tight junctions

Type A spermatogonia

Spermatogenesis

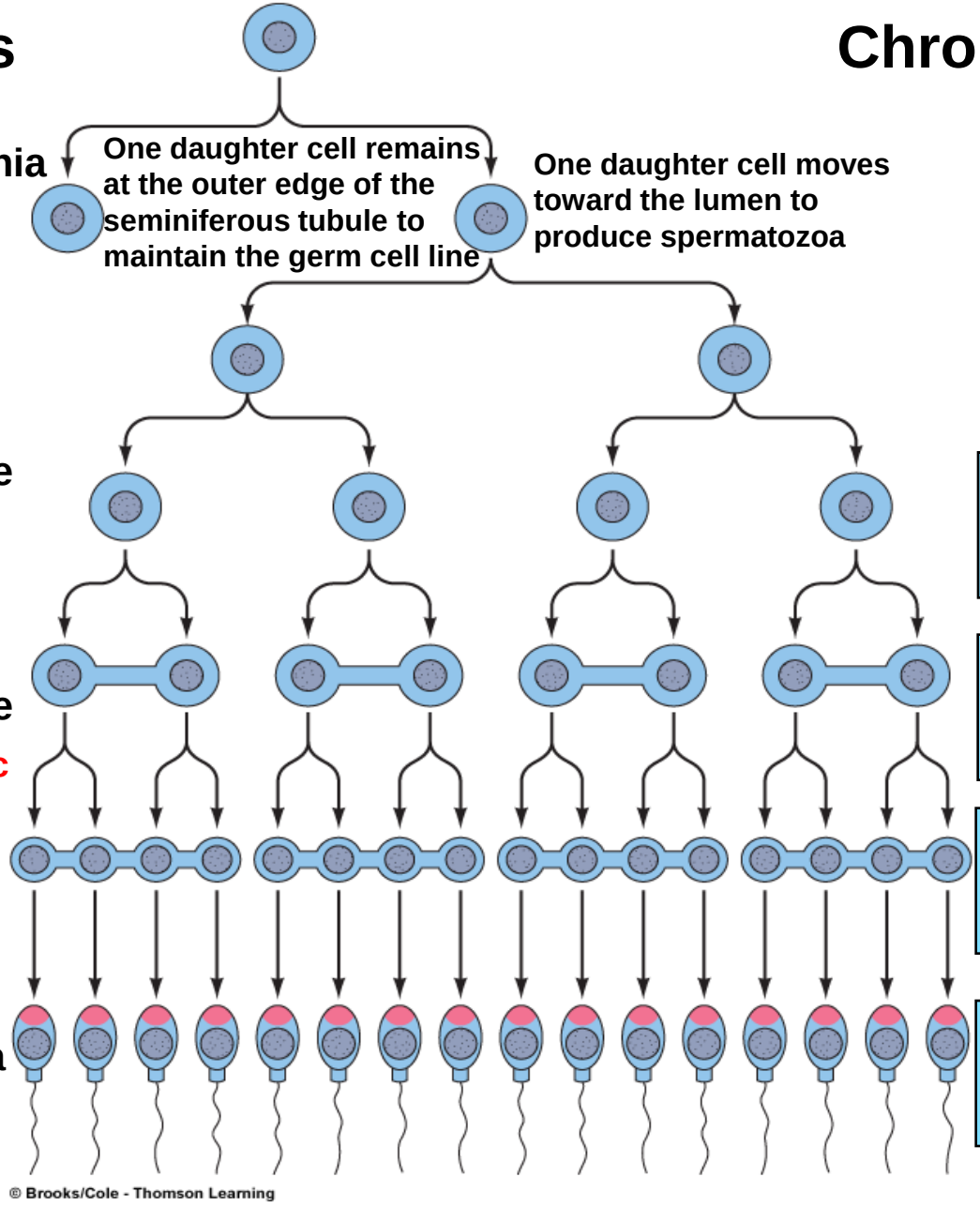
Stages:

Mitosis

Meiosis

Spermio-genesis

Chromosomes:



46; 2n (diploid number; single strands)

46; 2n (diploid number; single strands)

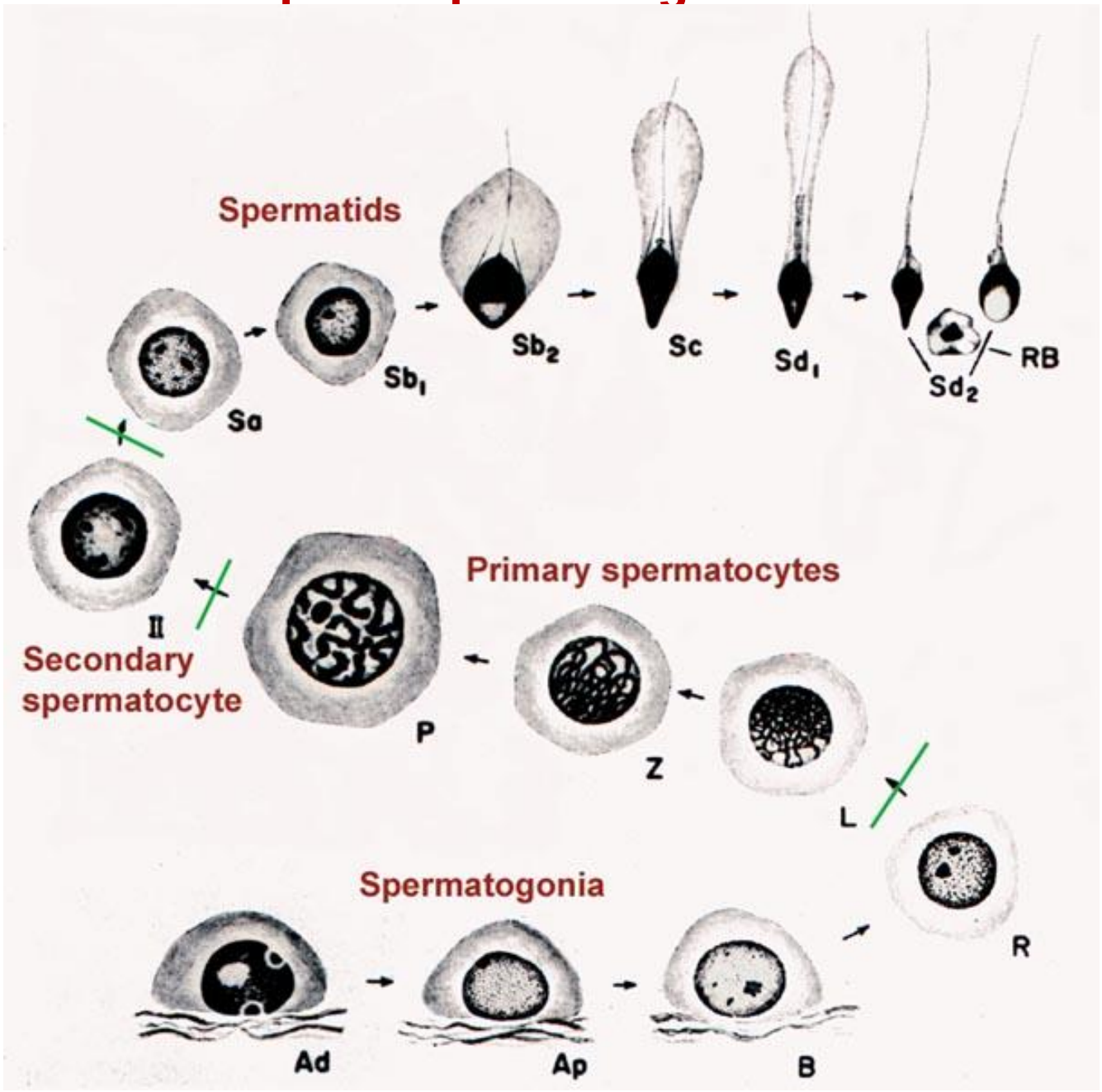
46; 2n (diploid number; doubled strands)

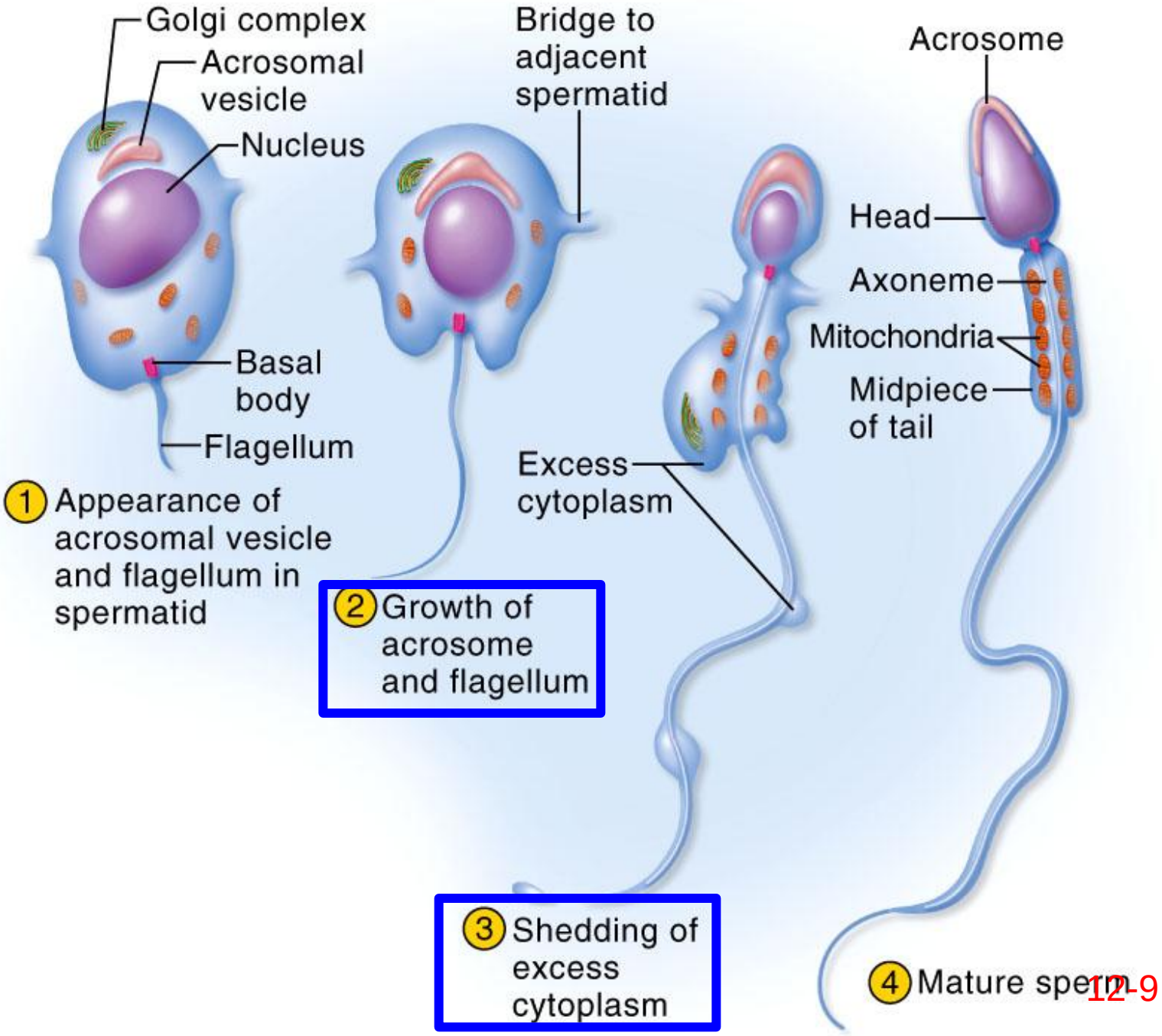
23; n (haploid number; double strands)

23; n (haploid number; single strands)

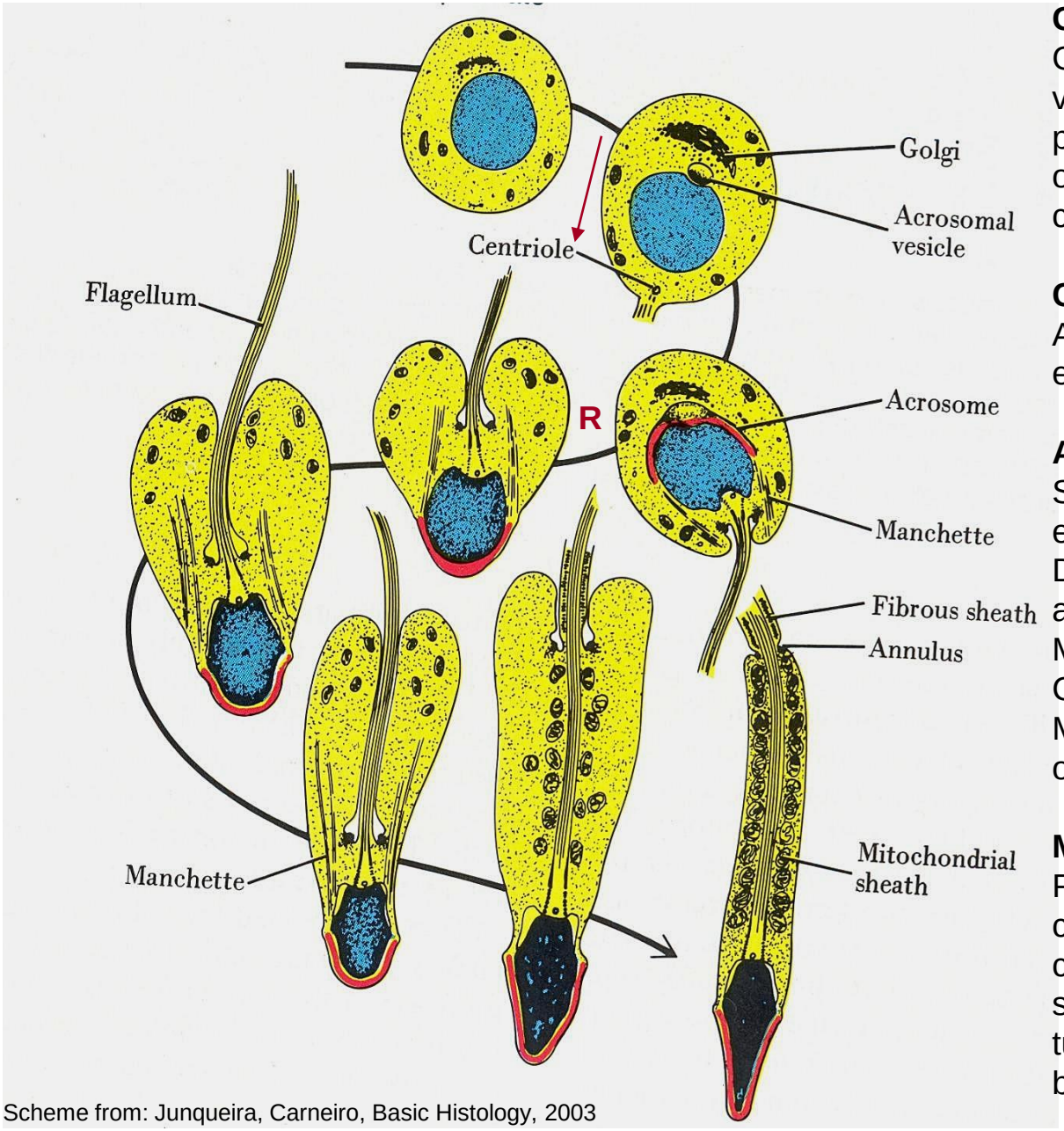
23; n (haploid number; Single strands)

Steps of spermatogenesis





SPERMIOGENESIS (SPERMATID PHASE – haploid spermatid differentiates into sperm)



Scheme from: Junqueira, Carneiro, Basic Histology, 2003

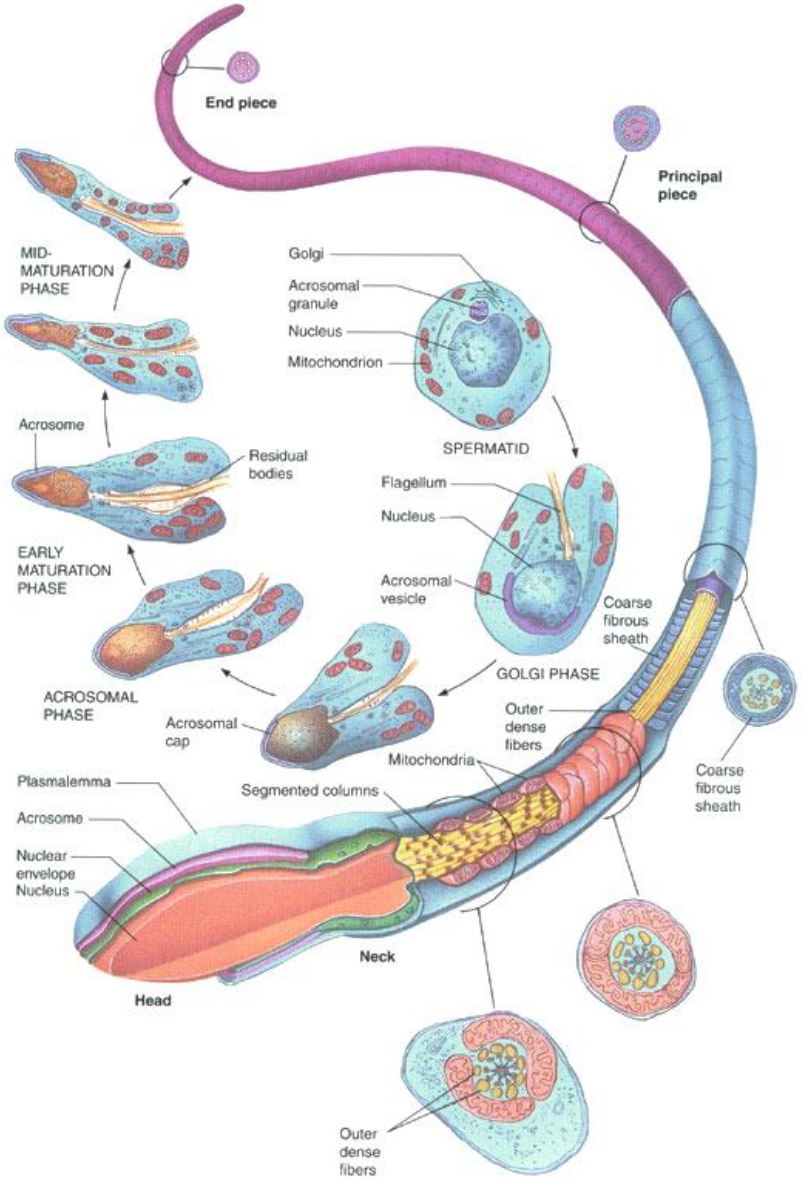
Golgi phase
Glycoprotein rich granule - acrosomal vesicle, mitochondria are displaced peripherally, centrioles migrate to the opposite pole of the nucleus, distal centriole begins to form axoneme

Cap phase
Acrosomal vesicle spreads and envelopes anterior of nucleus

Acrosome phase
Spermatid reorients (**R**) head is deeply embedded in Sertoli cell
Development of flagellum, condensation and elongation of nucleus
Microtubular manchette
Cytoplasm is displaced posteriorly
Mitochondria form mitochondrial sheath of the middle piece

Maturation phase
Progression of condensation of chromatin, phagocytosis of residual cytoplasm by Sertoli cells, release of spermatozoon into lumen of seminiferous tubule, and interruption of intercellular bridge

SPERMIOGENESIS



Hormonal Control of Spermatogenesis

- Formation of primary spermatocytes & entry into early prophase I, begin during embryonic development
  - Spermatogenesis is then arrested until puberty
  - Testosterone & its metabolites are required for completion of meiosis & spermatid maturation
    - A number of paracrines may also be involved
- FSH is not essential for spermatogenesis
  - It enhances T-stimulated spermatogenesis
  - & at puberty acts with T to stimulate proliferation of Sertolis

Hormone-cell interactions during spermatogenesis

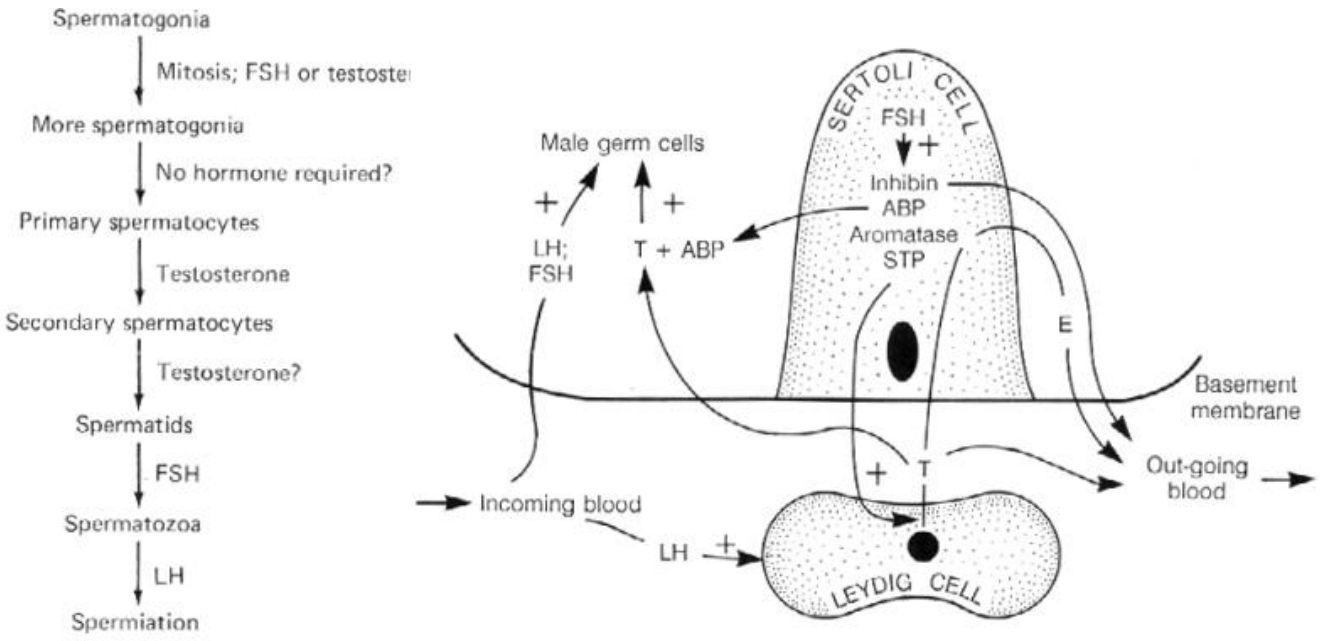
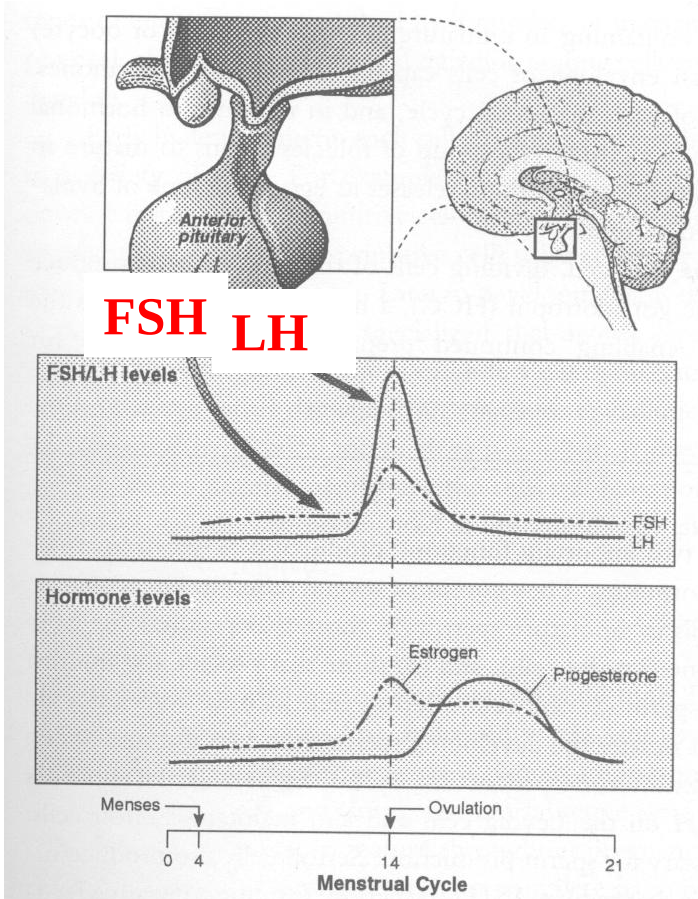


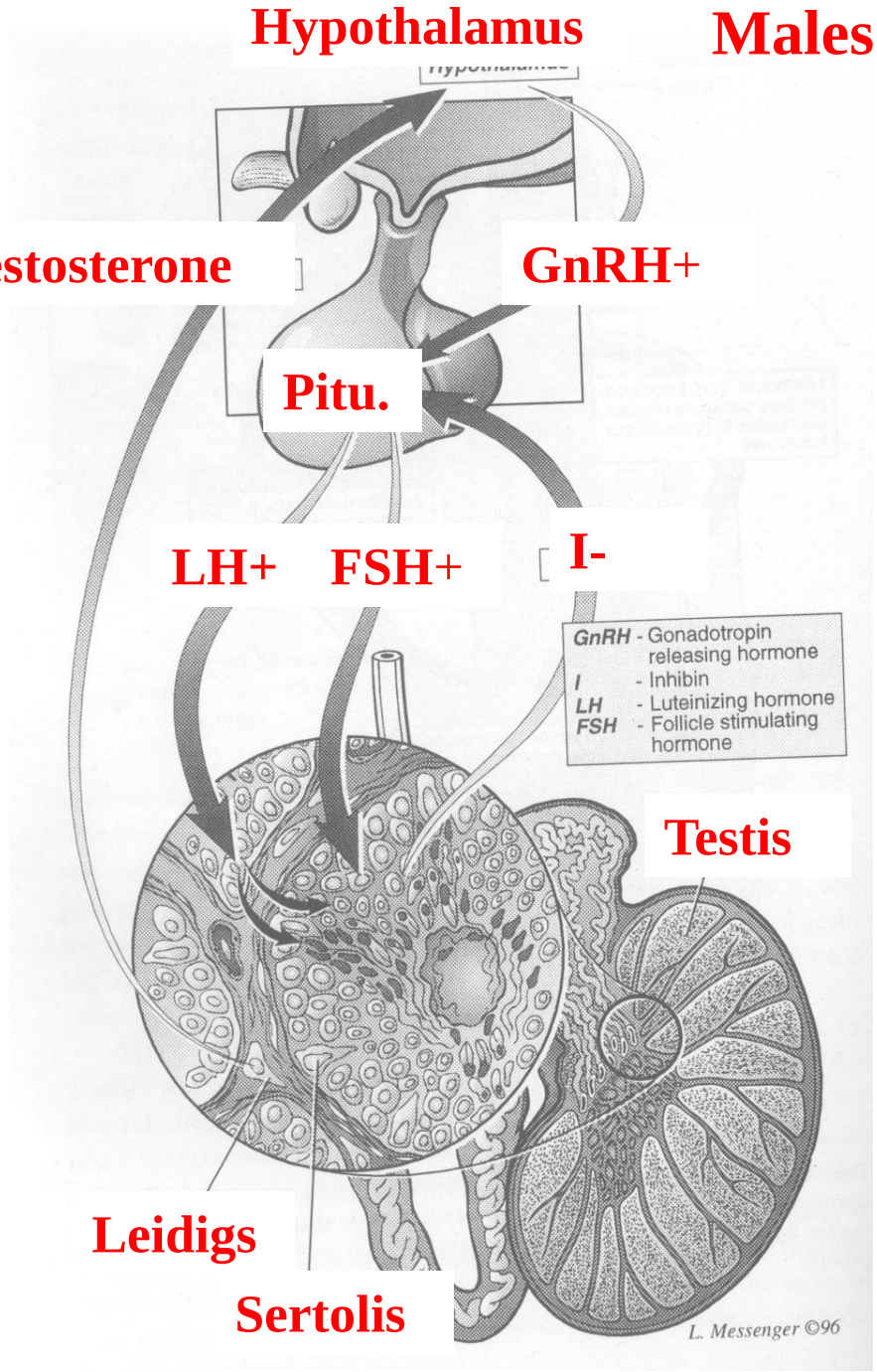
Figure 4–7 Endocrinology of the testes. The Leydig cell secretes testosterone (T) in response to LH delivered in the blood flow to the testes. T then diffuses into the seminiferous tubule and enters the Sertoli cells to be converted to estradiol (E) by aromatase enzyme. T also is present in the germ cell region, where some is bound to androgen-binding protein (ABP); some T remains "free" to stimulate steps of spermatogenesis (see Fig. 4-6). In addition, LH and FSH help in sperm production (Fig. 4-6). FSH also binds to the Sertoli cells and induces production of inhibin, ABP, aromatase, and steroidogenesis-stimulating protein (STP). The latter leaves the tubule and help LH to increase T production. Finally, inhibin, E, and T enter the outgoing blood to control target organs in the rest of the body and to exert negative feedback on gonadotropin secretion.

Hypothalamus-Pituitary-Gonadal Axis

Females



Males



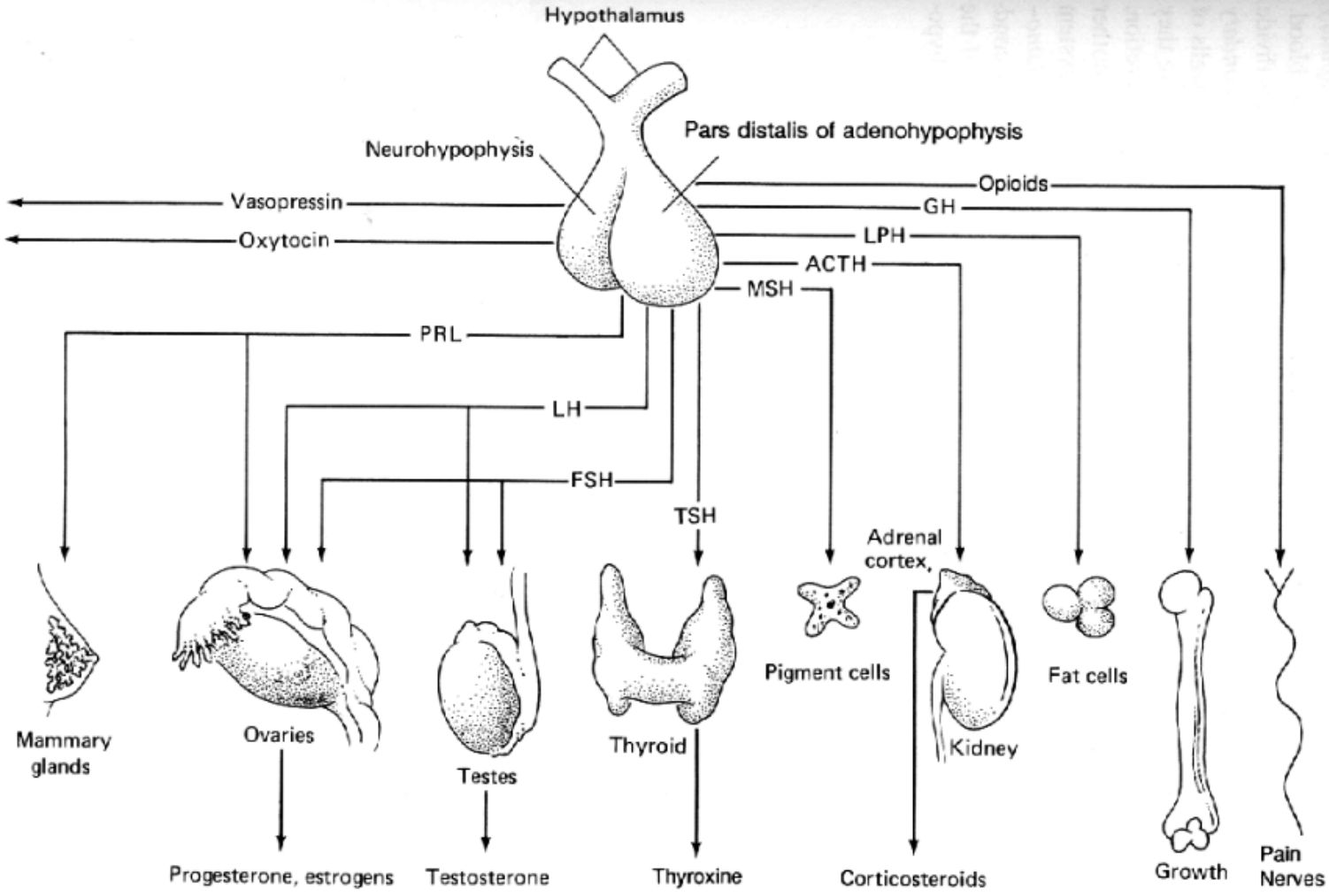


Figure 1–8 The hypophysis, connected to the hypothalamus at the base of the brain, has two lobes. The neurohypophysis stores and releases two hormones made in the hypothalamus: oxytocin and vasopressin. Oxytocin causes contraction of smooth muscle in the uterus, breast, and male reproductive tract. Vasopressin acts on the kidneys to cause water retention. The adenohypophysis secretes nine other hormones: growth hormone (GH) promotes growth; corticotropin (ACTH) causes the adrenal cortex to secrete corticosteroid hormones; follicle-stimulating hormone (FSH) and luteinizing hormone (LH) interact to regulate the function of the gonads; prolactin (PRL) causes milk synthesis in the mammary glands; thyrotropic hormone (TSH) stimulates the thyroid gland to secrete thyroxine; lipotropin (LPH) affects fat metabolism; melanophore-stimulating hormone (MSH) stimulates melanin synthesis in pigment cells; and opioids (endorphins and enkephalins) reduce pain.

From brain to gonad, and back again