

# **BIOLOGY Life on Earth**

**WITH PHYSIOLOGY** Tenth Edition

Audesirk Audesirk Byers

# 41

## Animal Reproduction

Lecture Presentations by  
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# Chapter 41 At a Glance

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- 41.1 How Do Animals Reproduce?
- 41.2 What Are the Structures and Functions of Human Reproductive Systems?
- 41.3 How Can People Prevent Pregnancy? (learned by yourselves)

Genetic Stability

# 41.1 How Do Animals Reproduce?

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- Animals reproduce either sexually or asexually

- In **asexual reproduction**

- usually through repeated **mitotic cell division** in some part of its body

- The offspring are therefore **genetically identical to the parents**

# 41.1 How Do Animals Reproduce?

- Animals reproduce either sexually or asexually (*continued*)
- 

- In **sexual reproduction**, organs called **gonads** produce haploid **sperm** or **eggs** through **meiotic cell division**
  - A sperm and egg—usually from separate parents—fuse to produce a **diploid fertilized egg**, or **zygote**, which then undergoes repeated **mitotic cell divisions** to produce an offspring
    - Because the **offspring** receives genes from both of its parents, it **is not genetically identical to either**

# 41.1 How Do Animals Reproduce?

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- In asexual reproduction, an organism reproduces without mating
  - Asexual reproduction is **efficient** in effort  
(no need to search for matescourt members of the opposite **sex**, or battle rivals), **materials** (no wasted gametes), and **genes** (the offspring have all the genes of their parent)

# 41.1 How Do Animals Reproduce?

There are several common **(four) methods of asexual reproduction** in the animal kingdom

## 1. **Budding** produces a miniature version of the adult

- Many sponges and cnidarians (such as corals, anemones, and *Hydra*) reproduce by **budding**



- In **budding**, new individuals arise from outgrowths of existing ones

# 41.1 How Do Animals Reproduce?

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## 2. **Fission** followed by **regeneration** can produce a new individual

- Many animals are capable of **regeneration**, the ability to re-grow lost body parts
- Regeneration is part of reproduction in species that reproduce by **fission**



(a)



(b)

# 41.1 How Do Animals Reproduce?

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3. During **parthenogenesis** (孤雌生殖), eggs develop without fertilization

- In some species, parthenogenetically produced offspring are **haploid**

Male honeybees

- Some parthenogenetic **fish, amphibians, and reptiles** produce **diploid** offspring by doubling the number of chromosomes in the eggs, either before or after meiosis
  - For example, the whiptail lizard of the southwestern United States and Mexico



Male honeybees



The whiptail lizard



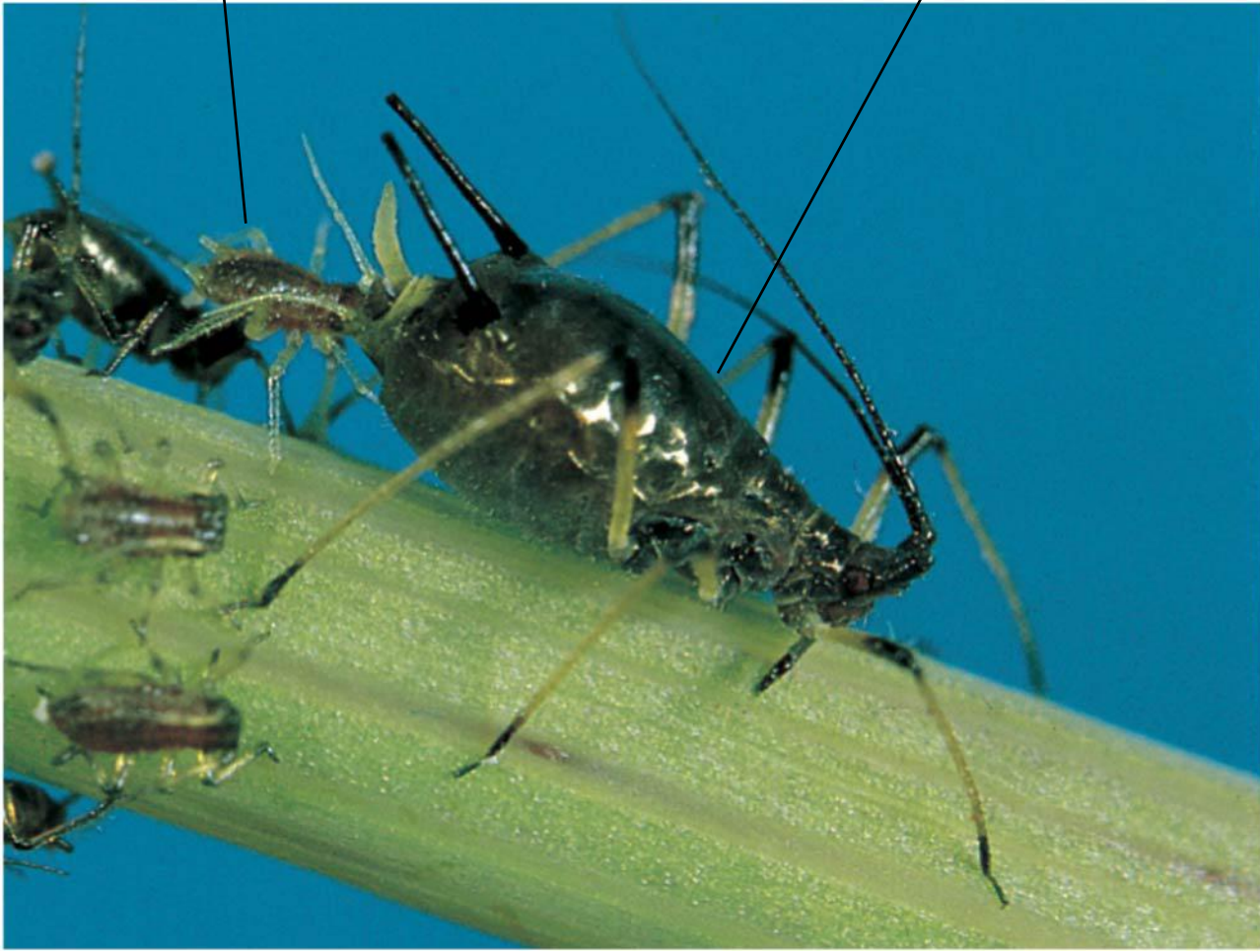
# 41.1 How Do Animals Reproduce?

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4. Still other animals, such as some aphids, can reproduce **either sexually or parthenogenetically**, depending on environmental factors such as the season of the year and the availability of food

Figure 41-3 A female aphid gives birth

offspring being born      adult female aphid



生活史复杂，无翅雌虫(干母 (stem mother))在夏季营孤雌生殖，卵胎生，产幼蚜。植株上的蚜虫过密时，有的长出两对大型膜质翅，寻找新宿主。夏末出现雌蚜虫和雄蚜虫，交配后，雌蚜虫产卵，以卵越冬，最终产生干母。

# 41.1 How Do Animals Reproduce?

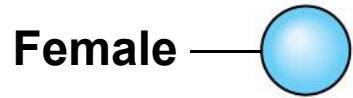
## sexual reproduction

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- In sexual reproduction, an organism reproduces via the union of sperm and egg

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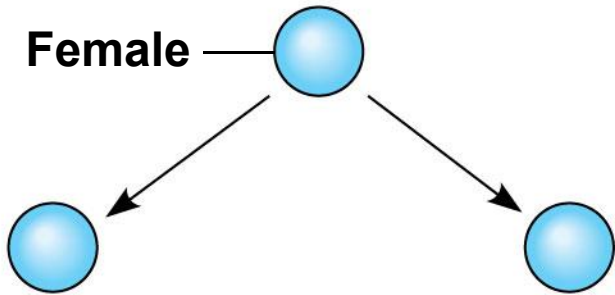
## Asexual reproduction



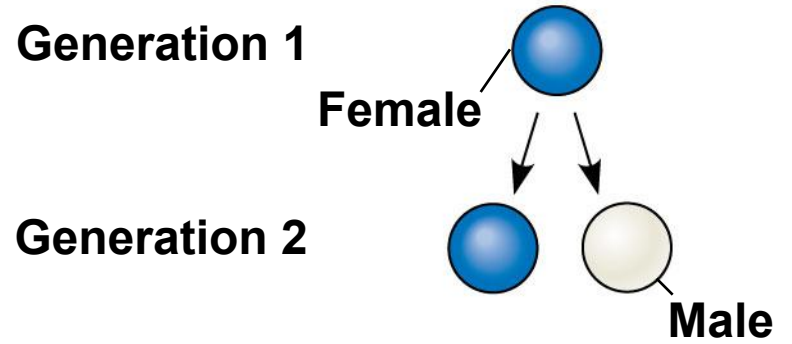
## Sexual reproduction



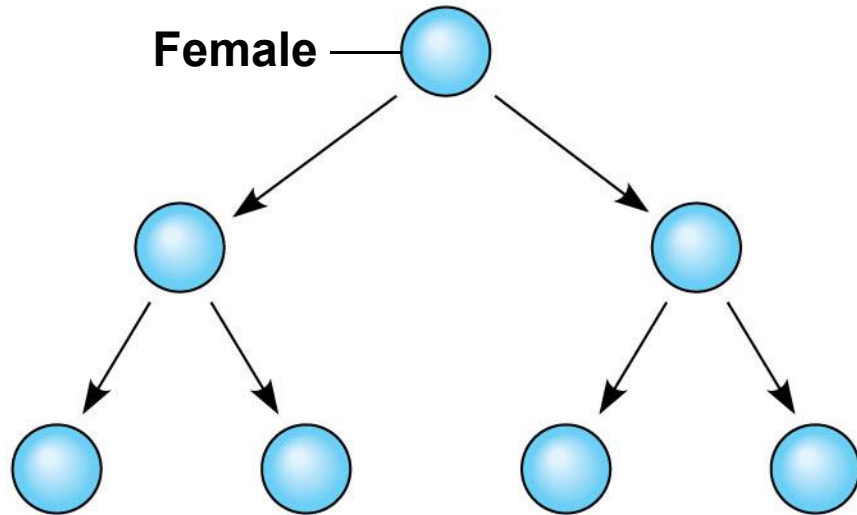
### Asexual reproduction



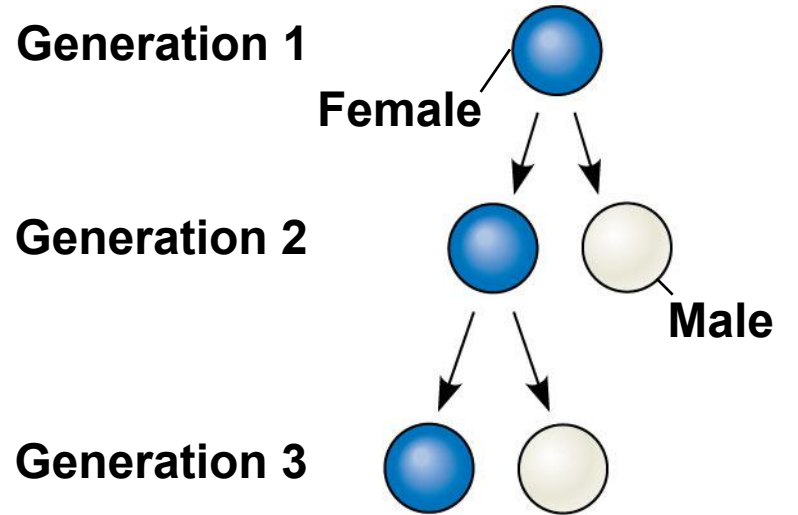
### Sexual reproduction



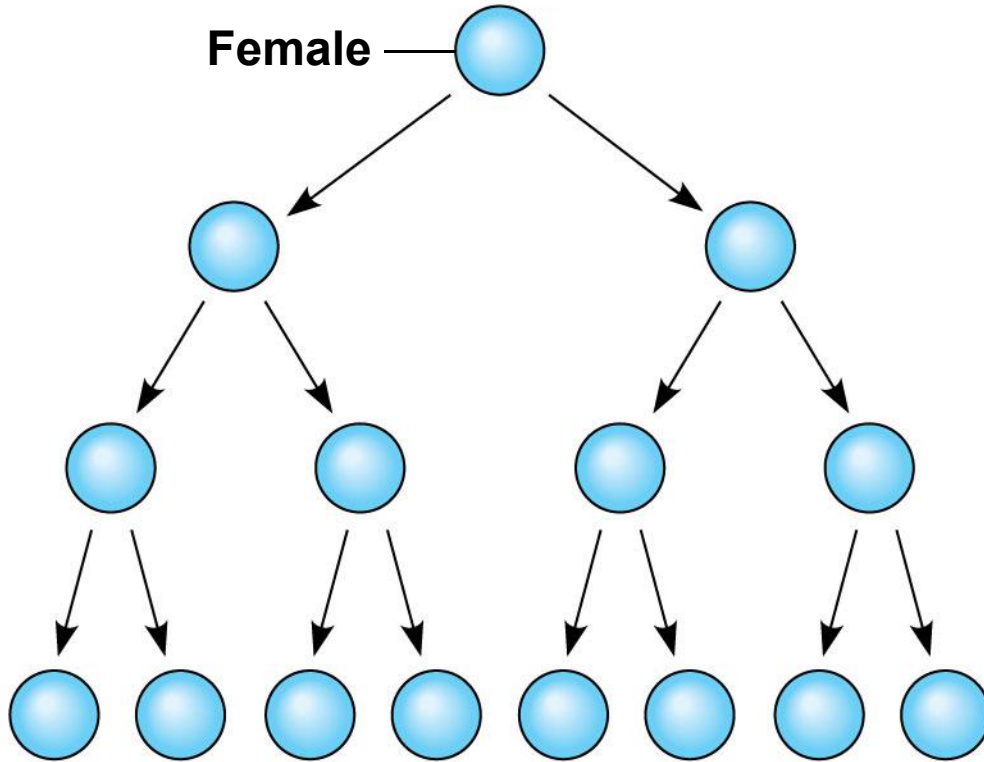
### Asexual reproduction



### Sexual reproduction

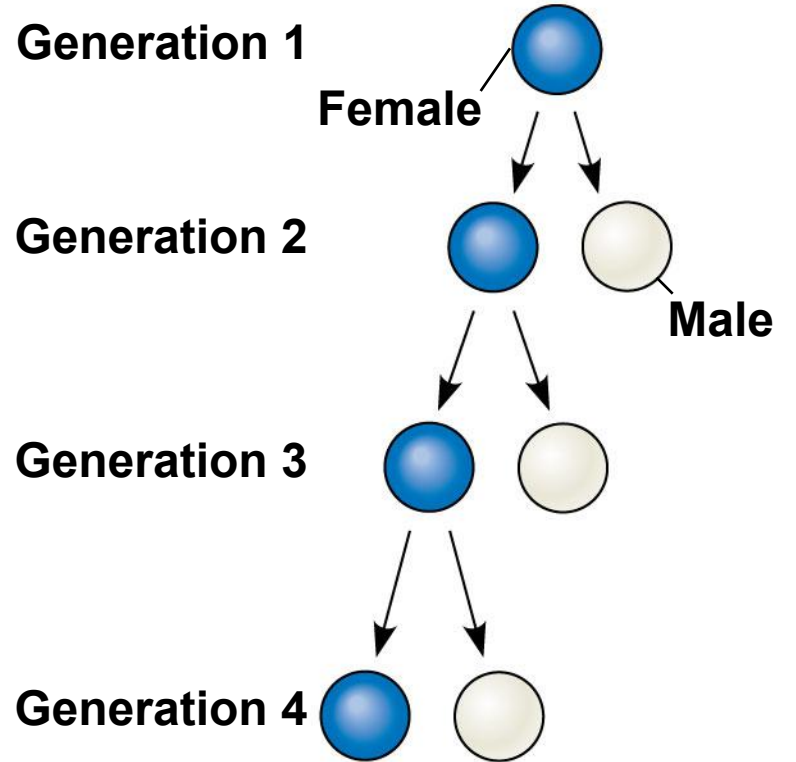


### Asexual reproduction



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### Sexual reproduction



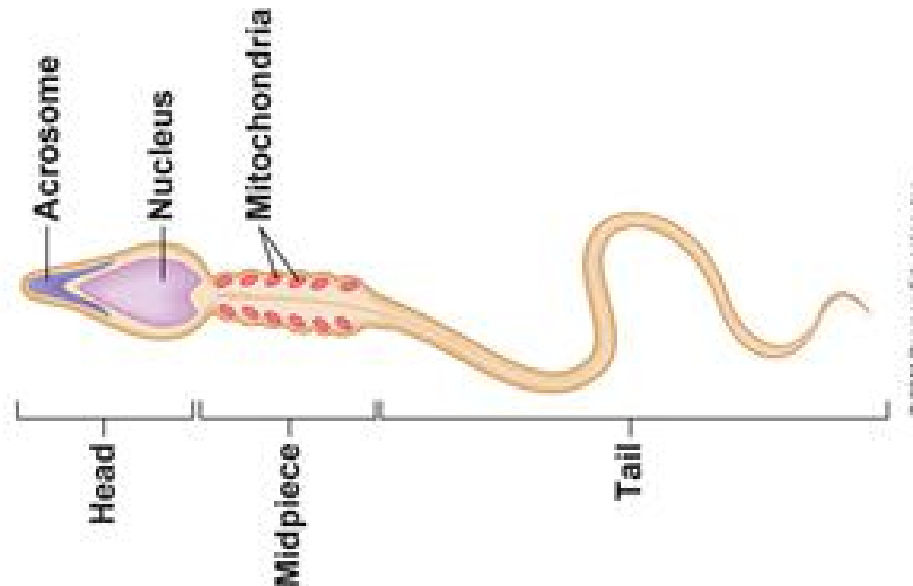


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- **Sexual reproduction** results in genetic recombination, which provides potential **advantages**
    - An increase in **variation** in offspring, providing an increase in the reproductive success of parents in **changing environments**
    - An increase in the rate of adaptation
    - A shuffling of genes and the elimination of harmful genes from a population

# 41.1 How Do Animals Reproduce?

## sexual reproduction

- In sexual reproduction, an organism reproduces via the union of sperm and egg
  - The male **gonad**, called the **testis** (plural, testes), produces **small, motile** haploid sperm, which have almost **no cytoplasm** and hence **no food reserves**



# 41.1 How Do Animals Reproduce?

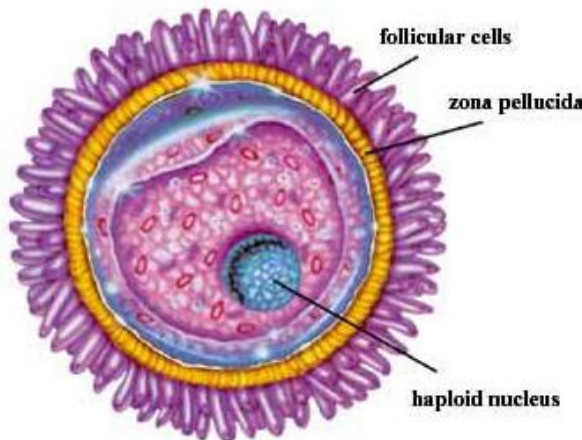
## sexual reproduction

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In most animals species, an individual is either **male** or **female**, defined by the type of gamete that each produces

- The **female gonad**, called the **ovary**, produces **eggs**

**large, haploid eggs** containing food reserves that provide nourishment for the **embryo**, an offspring in its early stages of development before birth or hatching





# Variation in Patterns of Sexual Reproduction

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- For many animals, finding a partner for sexual reproduction may be challenging
- 1. One solution is **hermaphroditism**, in which each individual has male and female reproductive systems

Two hermaphrodites can **mate**, and some hermaphrodites can **self-fertilize**

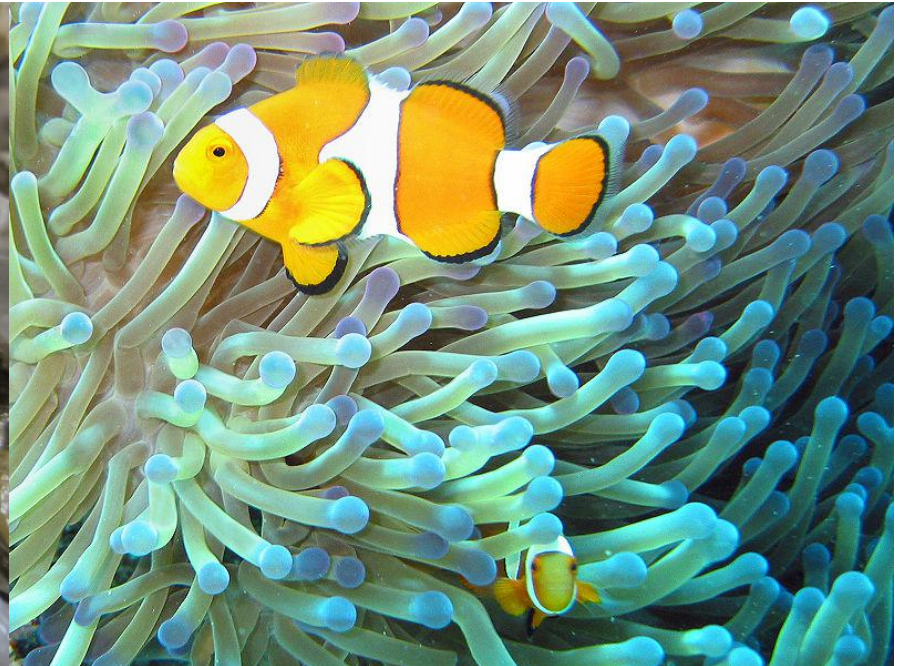


Earthworms and many snails, single individuals produce both sperm and eggs . Such individuals are called **hermaphrodites**(雌雄同体)

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## 2. Individuals of some species undergo **sex reversals**

Some species exhibit male to female reversal (for example, certain oysters), while others exhibit female to male reversal (for example, a coral reef fish)



# 41.1 How Do Animals Reproduce?

sexual reproduction

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**Fertilization**, the union of sperm and egg, forms a **diploid zygote**

- The mechanisms of **fertilization**, the union of egg and sperm, play an important part in sexual reproduction
- In **external fertilization**, eggs shed by the female are fertilized by sperm in the external environment

**internal fertilization**



# 41.1 How Do Animals Reproduce?

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- In sexual reproduction, an organism reproduces via the union of sperm and egg (*continued*)
  - **External fertilization** occurs outside the parents' bodies
  - eggs shed by the female are fertilized by sperm in the external environment
    - sperm and egg unite outside the bodies of the parents
      - Sperm and eggs are typically released into water, a process called **spawning**, and the sperm swim to reach the eggs
  - Because sperm and eggs are relatively short lived, spawning animals must **synchronize** their reproductive behaviors both **temporally** (male and female spawn at the same time) and **spatially** (male and female spawn in the same place)

# 41.1 How Do Animals Reproduce?

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- Most spawning animals rely on **environmental cues** to some extent
  - **Seasonal changes in day length** often stimulate the physiological changes required for breeding, and this restricts breeding to certain times of year

—For example, many coral species of Australia's Great Barrier Reef synchronize spawning by **the phase of the moon**, simultaneously releasing a blizzard of sperm and eggs into the water

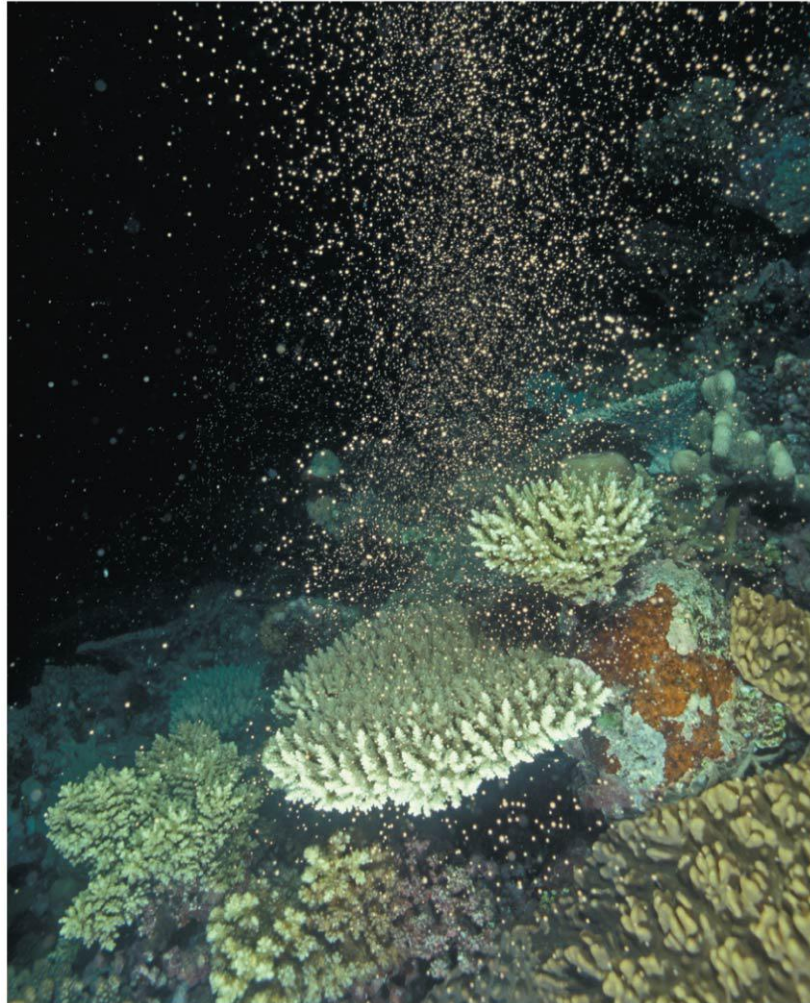
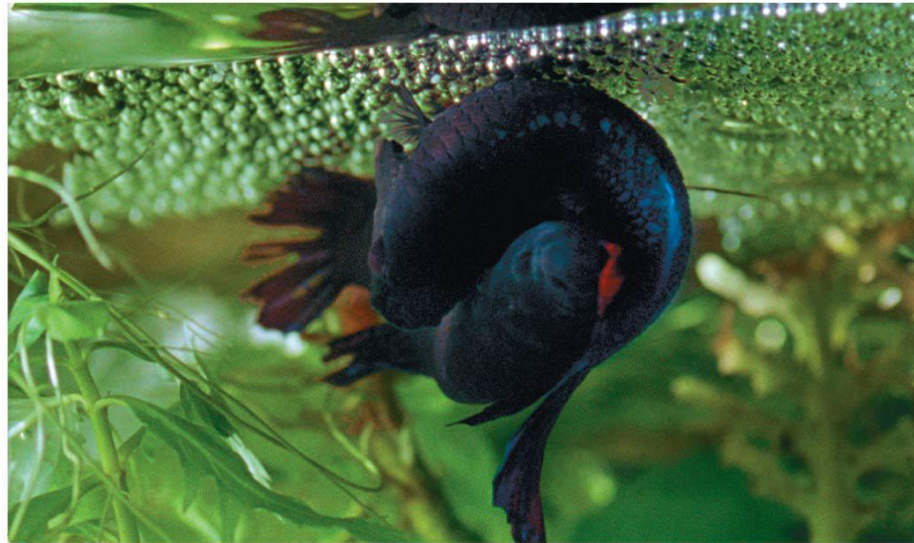


Figure 41-5 Environmental cues may synchronize spawning

# 41.1 How Do Animals Reproduce?

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- Many animals rely on **mating behaviors** to synchronize spawning
  - Most fish, for example, have courtship rituals, ensuring that they release their gametes in the same place and at the same time



**Figure 41-6** Courtship rituals synchronize spawning

# 41.1 How Do Animals Reproduce?

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- In sexual reproduction, an organism reproduces via Frogs and toads mate in shallow water near the edges of ponds and lakes



Figure 41-7 Golden toads mating

# 41.1 How Do Animals Reproduce?

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**During internal fertilization**, sperm are placed within the female's moist reproductive tract, where the egg is fertilized

- Internal fertilization is an important adaptation to **terrestrial life** because sperm quickly die if they **dry out**
- Internal fertilization occurs within the female's body
  - Even **in aquatic environments**, internal fertilization may **increase the likelihood of success** because the sperm and eggs are confined in a small space rather than dispersed in a large volume of water

# 41.1 How Do Animals Reproduce?

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- In sexual reproduction, an organism reproduces via the union of sperm and egg (*continued*)
  - Internal fertilization usually occurs by **copulation**, in which the male deposits sperm directly into the female's reproductive tract
  - Males of some species, including some salamanders, scorpions, and grasshoppers, package their sperm in a container called a *spermatophore*

Figure 41-8 Internal fertilization allows reproduction on land





# 41.1 How Do Animals Reproduce?

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- In sexual reproduction, an organism reproduces via the union of sperm and egg (*continued*)
  - Internal fertilization occurs within the female's body (*continued*)
    - In most animals, **neither sperm nor eggs live very long**
      - Therefore, **ovulation**, the release of a mature egg cell from the ovary of the female, usually must occur about the same time the sperm are deposited in the female's reproductive tract

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The following section focuses on the human  
reproductive system

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- People and other mammals have separate sexes, copulate, and fertilize their eggs internally
  - Although most mammals reproduce only during certain seasons of the year, men produce sperm more or less continuously, and women ovulate about once a month

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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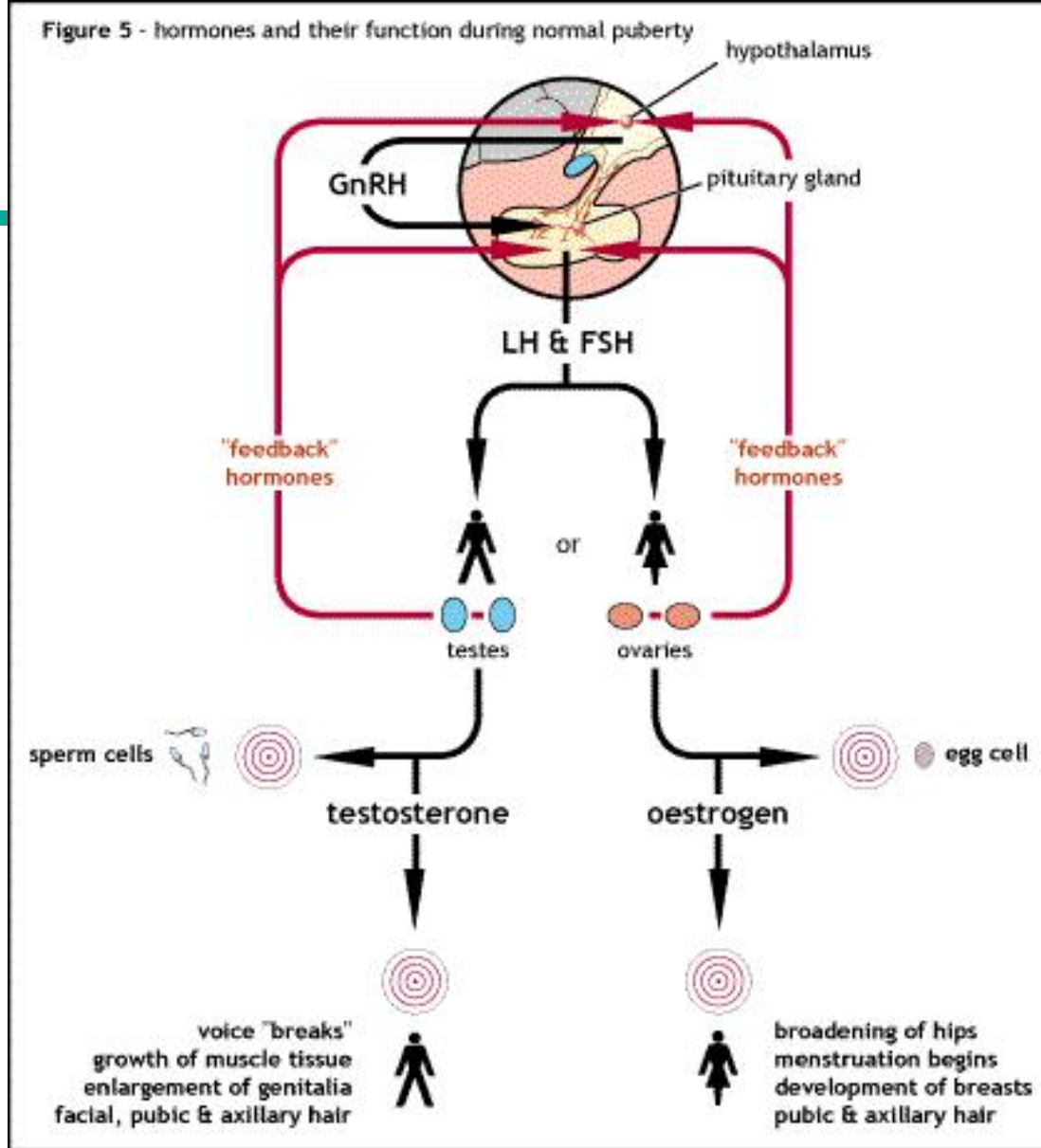
- The ability to reproduce begins at puberty
  - **Sexual maturation** in humans occurs at **puberty**, a stage of development characterized by rapid growth and the appearance of **secondary sexual characteristics in both sexes**
  - In both sexes, **brain maturation** causes the **hypothalamus** to **release gonadotropin-releasing hormone (GnRH)**, which stimulates the anterior **pituitary** to produce **luteinizing hormone (LH)** and **follicle-stimulating hormone (FSH)**

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The ability to reproduce begins at puberty (*continued*)
  - Although LH and FSH derive their names from their functions in females, they are equally essential in males
  - LH and FSH stimulate the testes to produce the male sex hormone **testosterone** and the ovaries to produce the female sex hormone **estrogen**

Figure 5 - hormones and their function during normal puberty



## Flow diagram showing normal hormonal control of puberty

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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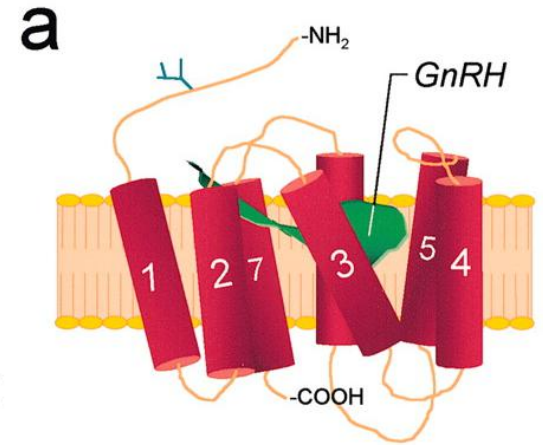
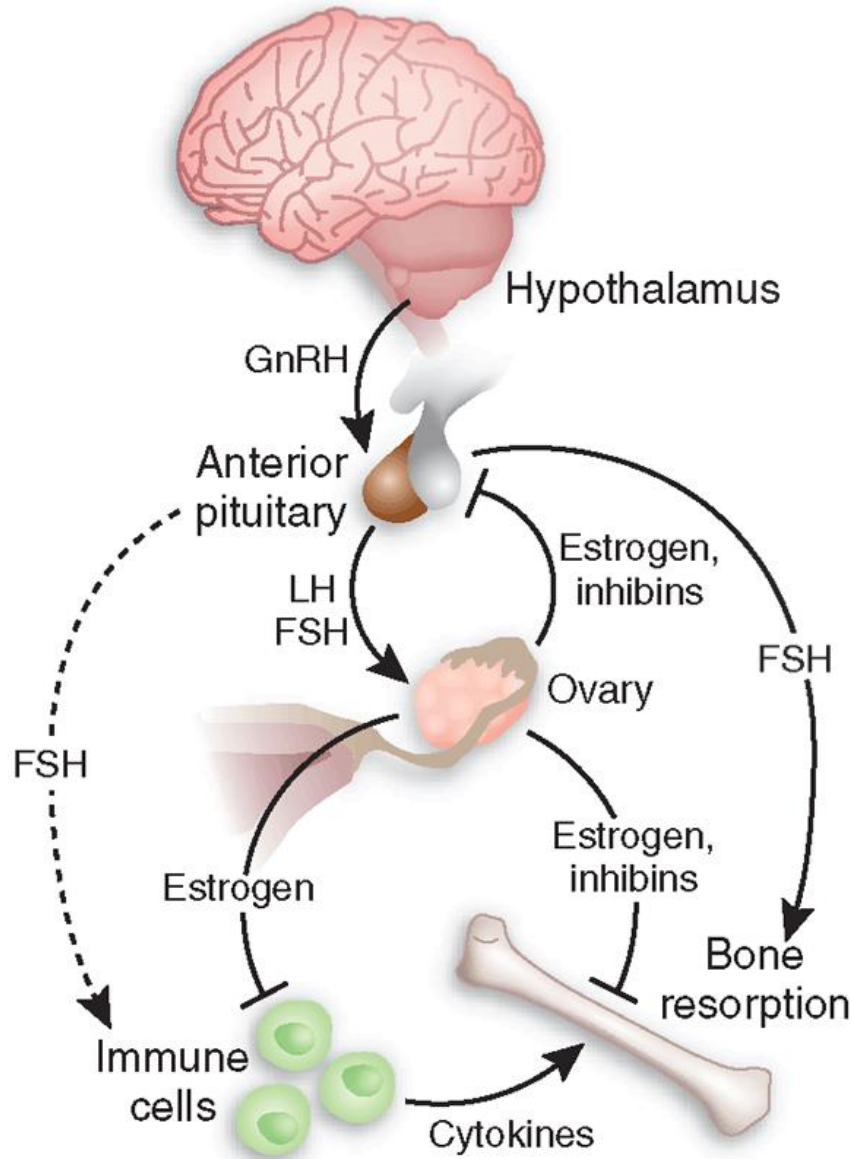
- The ability to reproduce begins at puberty (*continued*)
  - In response to increases in testosterone, males develop secondary **sexual characteristics**
    - The penis and testes enlarge
    - Pubic, underarm, and facial hair appears
    - The larynx enlarges, deepening the voice
    - Muscular development increases

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The ability to reproduce begins at puberty (*continued*)
  - In response to increased estrogen and other hormones that surge at puberty, **females develop secondary sexual characteristics**
    - Breasts enlarge
    - The hips become wider
    - Pubic and underarm hair appears
    - Menstruation begins
  - Courtship behaviors start to appear in both sexes





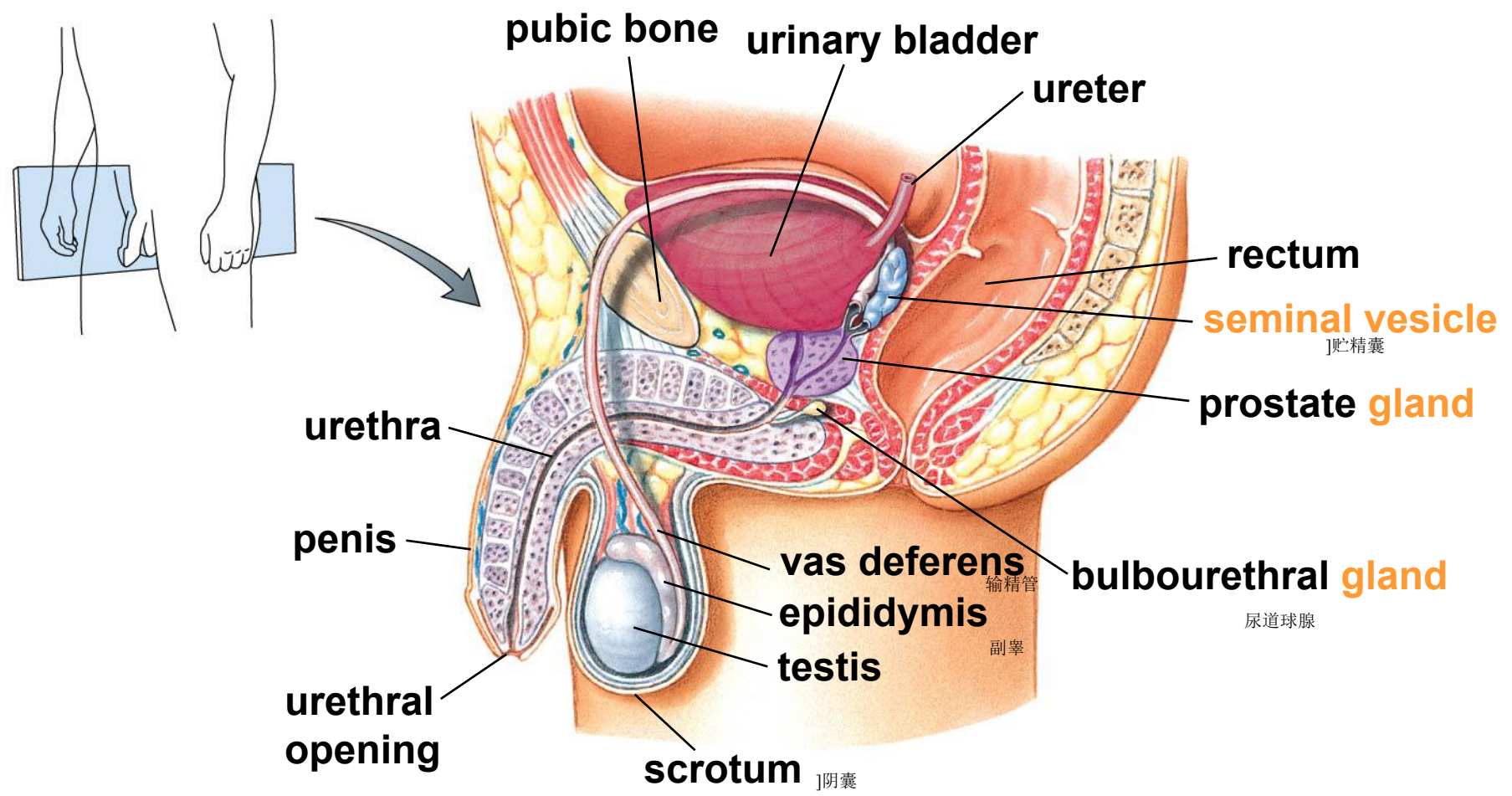
**The potential effects of FSH on the skeleton *in vivo*, either directly upon bone or indirectly.**

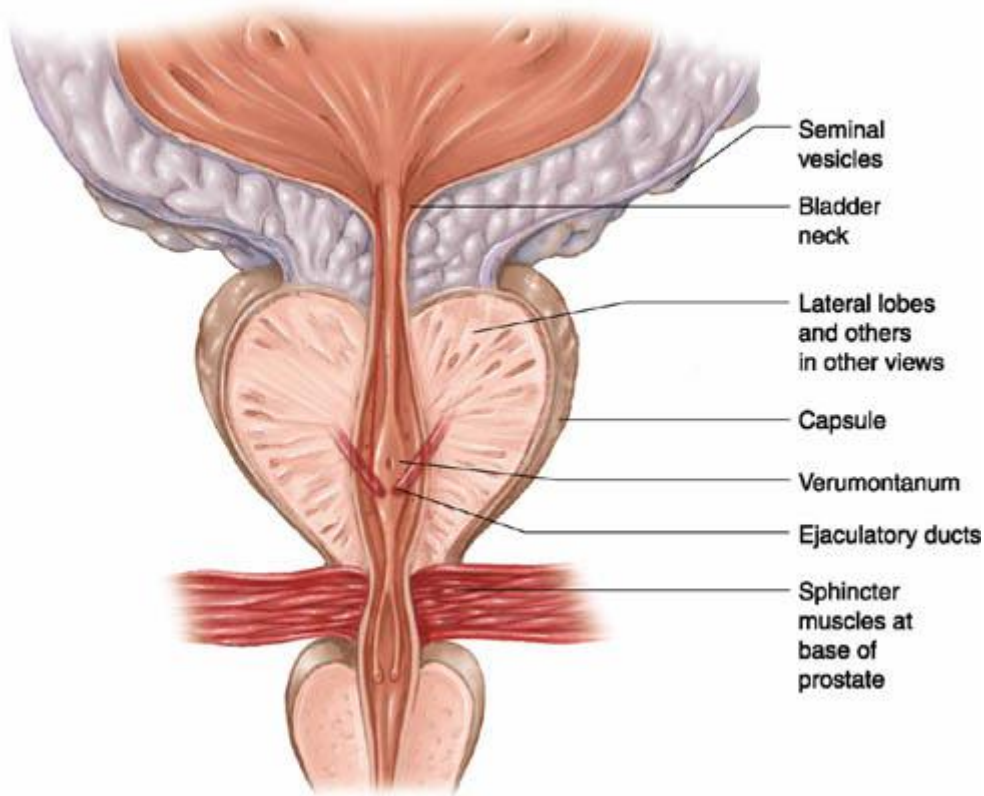
## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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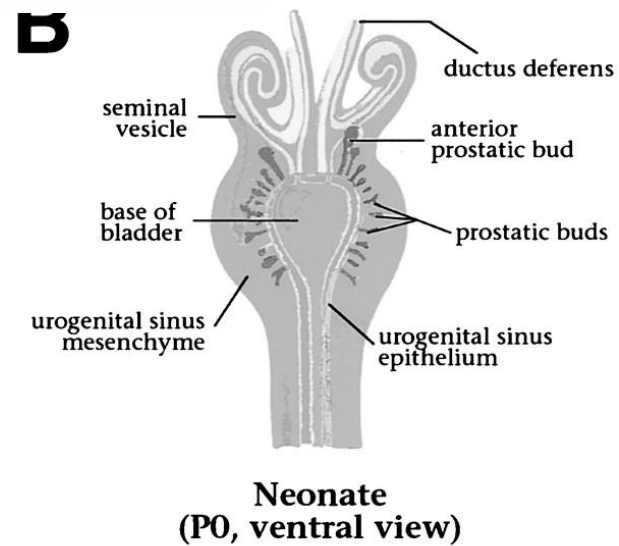
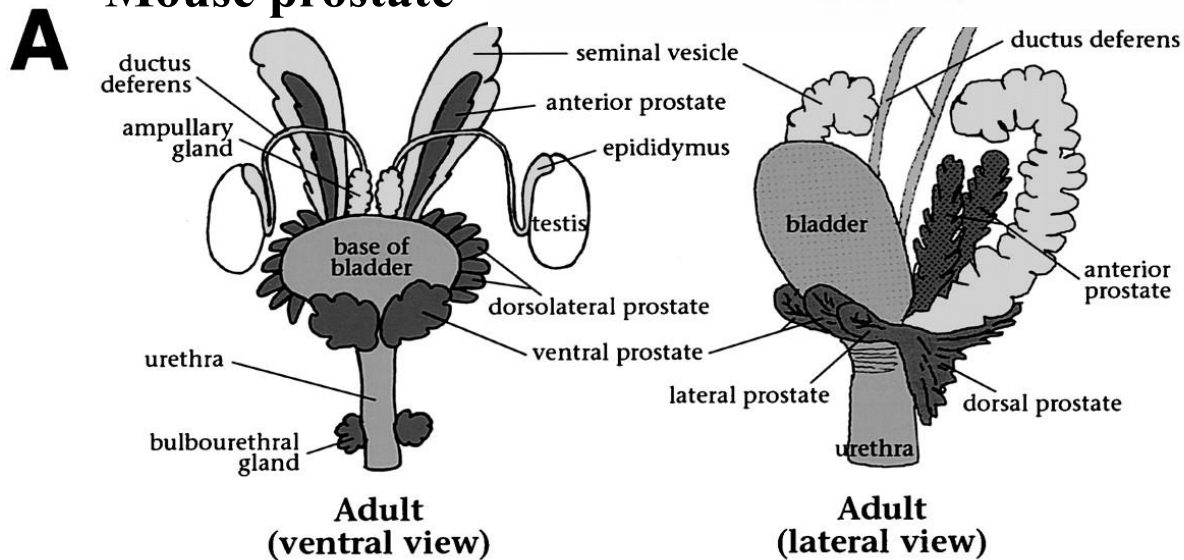
- The **male reproductive** system includes the **testes** and **accessory structures**
  - **Testes** that produce **testosterone** and **sperm**
  - **Glands** that secrete substances to **activate** and nourish sperm
  - **Tubes** that store sperm and conduct them out of the body
- Testosterone and sperm production are nearly continuous and last until death

Figure 41-9 The human male reproductive system





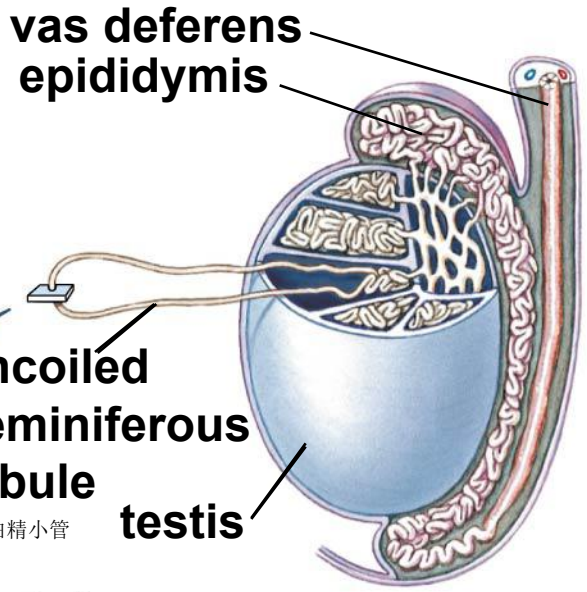
## Mouse prostate



## TABLE 41-1 The Human Male Reproductive Tract

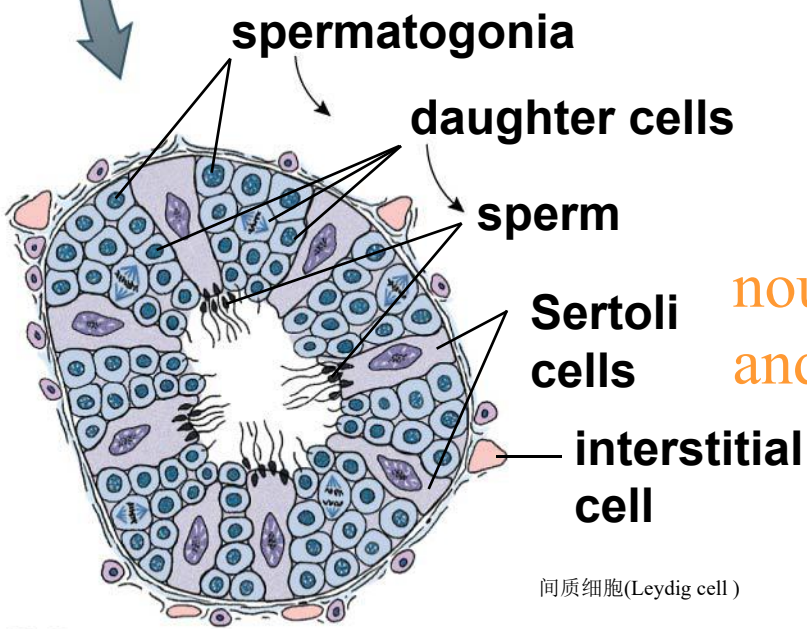
Structure	Function
Testis (male gonad)	Produces sperm and testosterone
Epididymis and vas deferens (ducts)	Store sperm; conduct sperm from the testes to the urethra
Urethra (duct)	Conducts semen from the vas deferens and urine from the urinary bladder to the tip of the penis
Penis	Deposits sperm in the female reproductive tract
Seminal vesicles (glands)	Secrete fluid into the semen
Prostate gland	Secretes fluids into the semen
Bulbourethral glands	Secrete fluid into the semen

Figure 41-10 The anatomy of the testes



sperm are produced

**(a) A section through the testis**



nourish the developing sperm and regulate their growth

synthesize testosterone

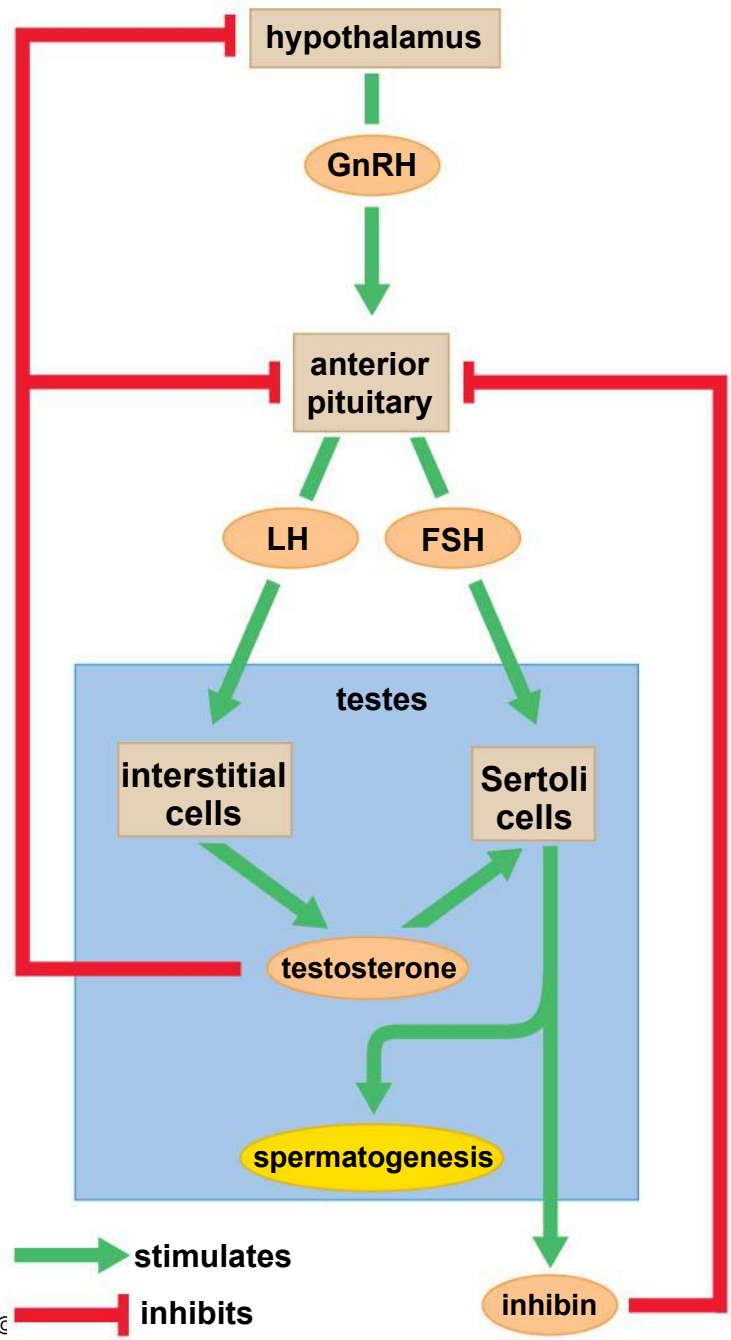
**(b) Cross-section of a seminiferous tubule**

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The male reproductive system includes the testes and accessory structures (*continued*)
  - Sperm are produced in the testes
    - The testes are located in the **scrotum**, a pouch that hangs outside the main body cavity
      - This location keeps the testes about 1° to 6° F (about 0.5° to 3° C) cooler than the core of the body,
      - Cooler temperatures promote sperm development

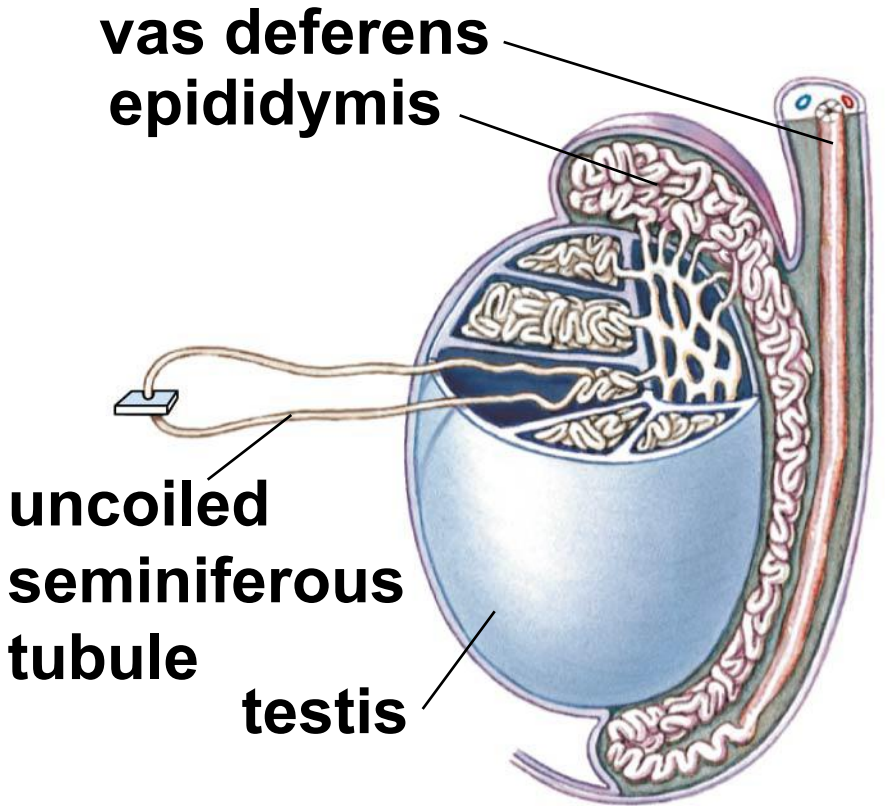
Figure 41-13 Hormonal control of spermatogenesis



—This complex feedback process maintains relatively constant levels of testosterone and sperm production



Figure 41-10a A section through the testis



**vas deferens**  
**epididymis**

**uncoiled**  
**seminiferous**  
**tubule**

**testis**

**seminiferous tubules**



**epididymis,**



**vas deferens**

**vas deferens joins the urethra**  
**penis**

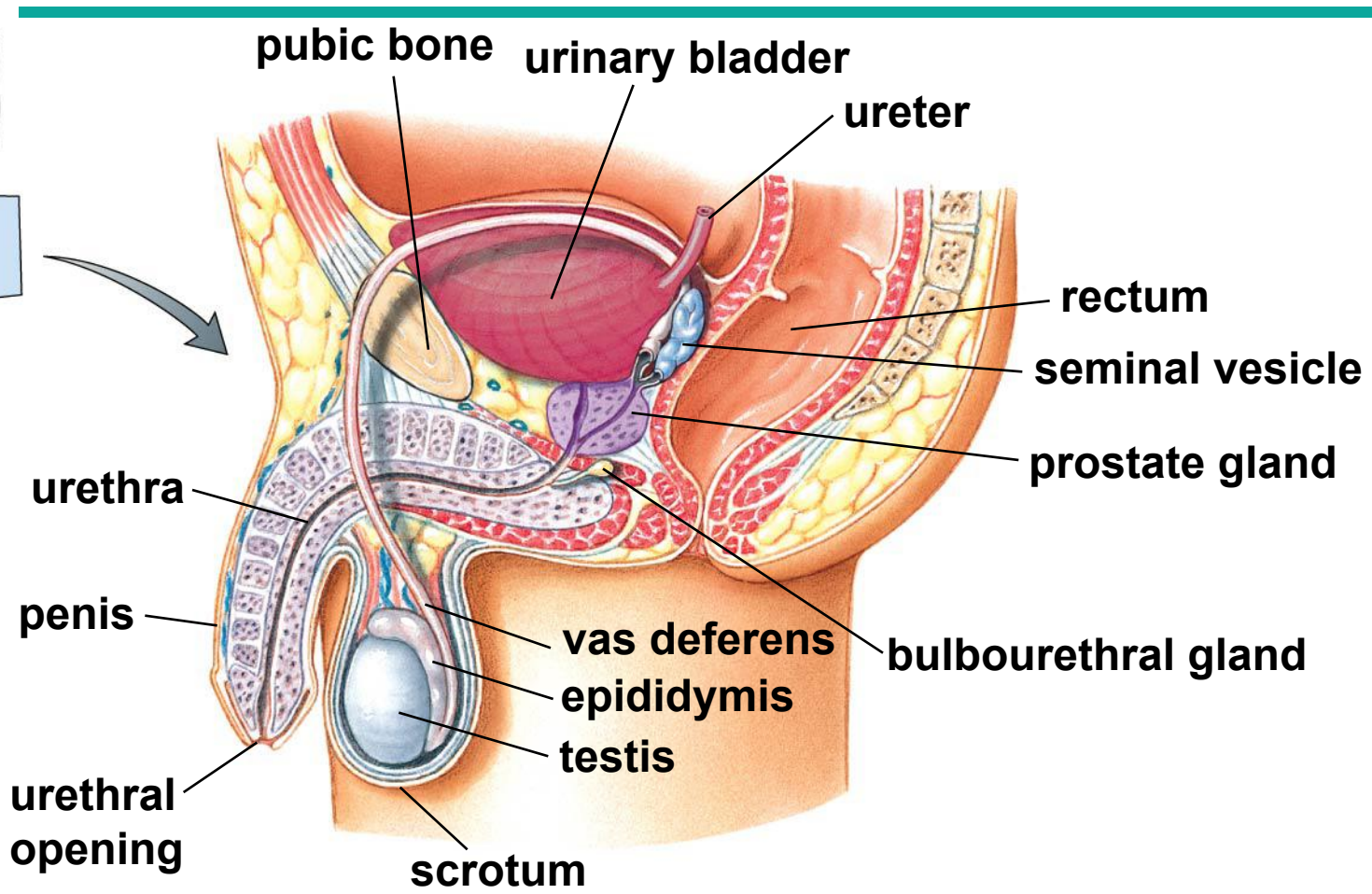
**(a) A section through the testis**

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- accessory structures (*continued*)
  - Accessory structures contribute to semen and conduct the sperm outside the body (*continued*)
    - Men ejaculate a fluid, called **semen**, that consists of about **5% sperm**, mixed with **secretions** from three types of glands that empty into the vas deferens or the urethra
      1. **The seminal vesicles** comprises about 60% of the semen, rich in **fructose**, **energy for** the sperm
      2. **The prostate gland**
      3. **The bulbourethral glands**

Figure 41-9 The human male reproductive system



## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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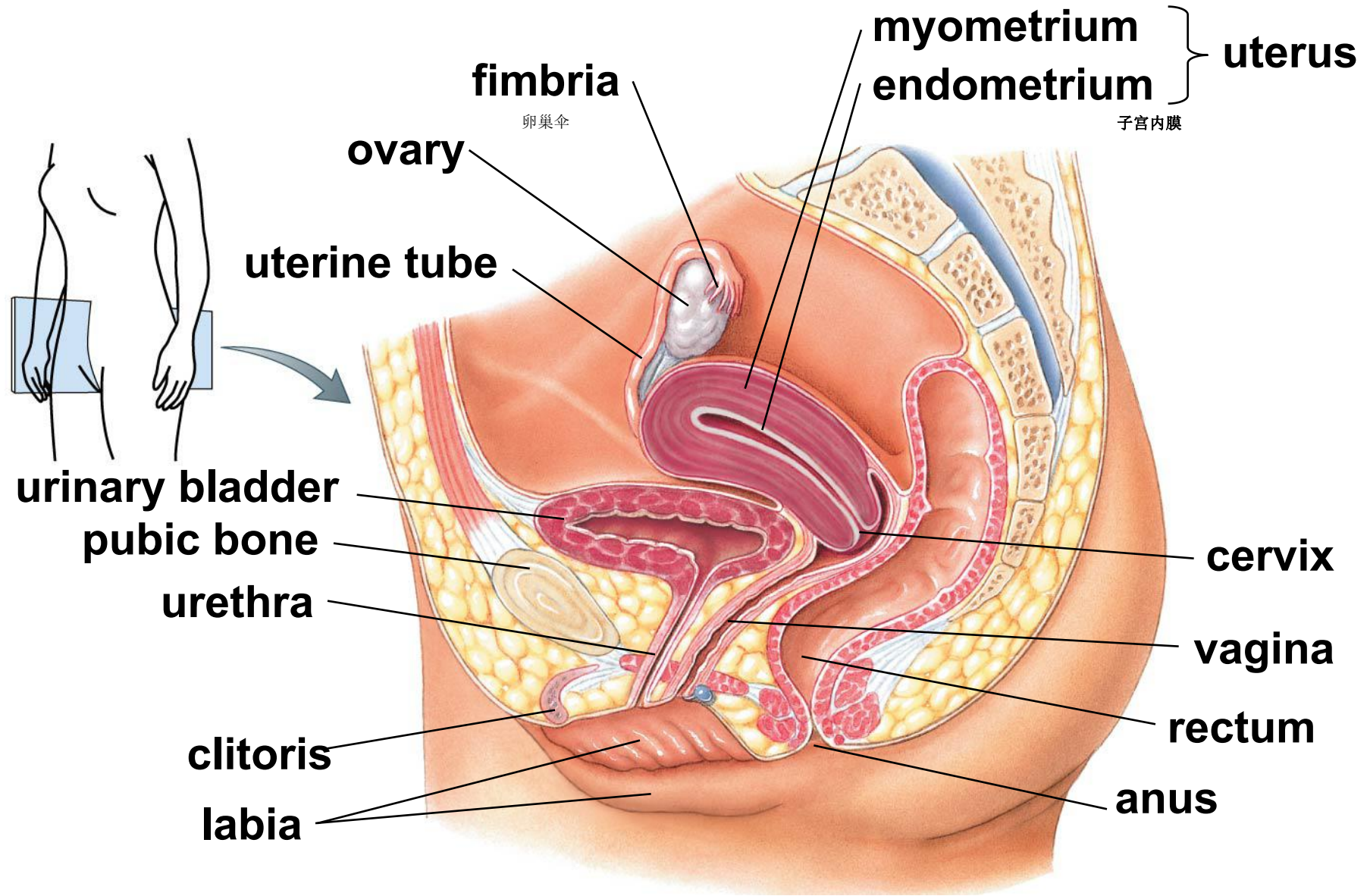
- **semen**
  1. The **seminal vesicles** comprises about **60%** of the semen, rich in **fructose**, energy for the sperm
  2. The **prostate gland** produces an **alkaline**, nutrient-rich secretion that comprises about **30%** of the semen volume. The prostate fluid includes **enzymes** that increase the fluidity of the semen after it is released into the vagina, allowing the sperm to swim more freely
  3. The **bulbourethral glands** secrete a small amount of **alkaline mucus** into the urethra, neutralizing remaining traces of **acidic urine**
- Its slightly **alkaline pH**
- It also contains **prostaglandins**,

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

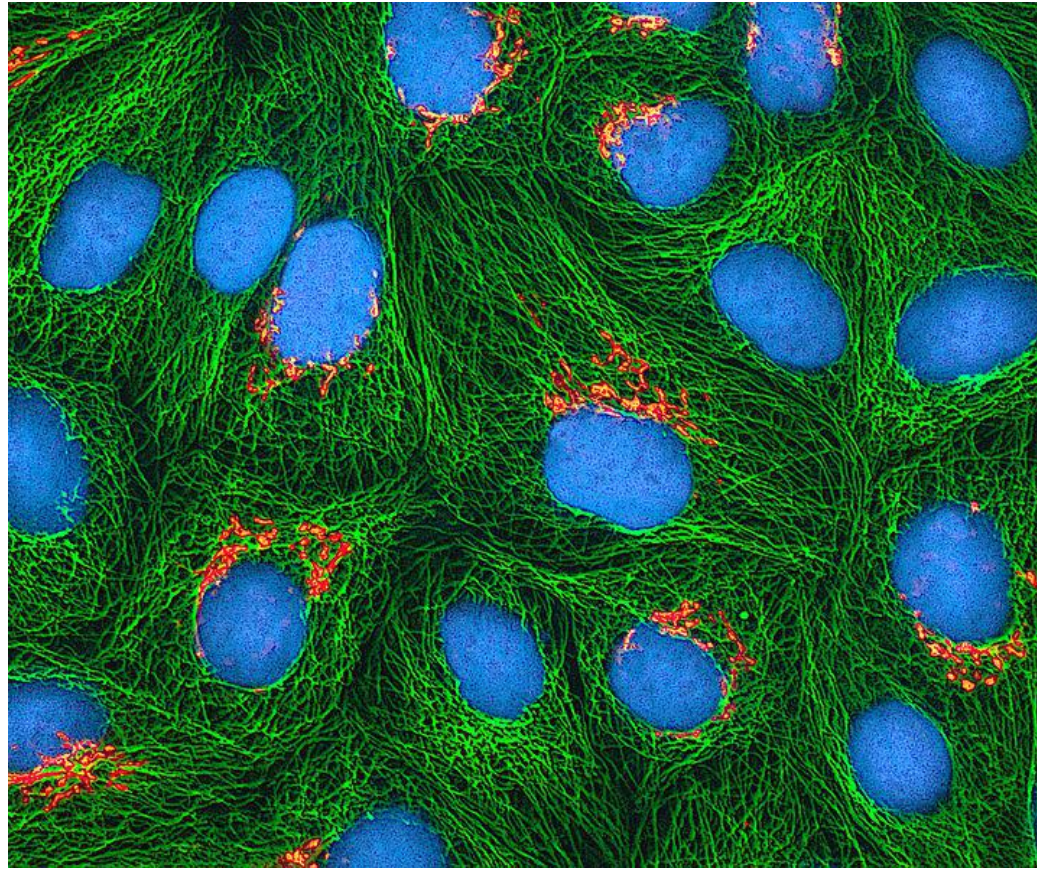
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- The female reproductive system includes the ovaries and accessory structures
  - The ovaries and accessory structures
    - Accept sperm
    - Conduct sperm to the egg
    - Nourish the developing embryo

Figure 41-14 The human female reproductive system



# HeLa cell :derived from cervical cancer cells



Multiphoton fluorescence image of cultured HeLa cells with a fluorescent protein targeted to the Golgi apparatus (orange), microtubules (green) and counterstained for DNA (cyan).

## TABLE 41-2 The Human Female Reproductive Tract

<b>Structure</b>	<b>Function</b>
Ovary (female gonad)	Produces eggs, estrogen, and progesterone
Fimbriae (at the opening of the uterine tube)	Bear cilia that sweep the egg into the oviduct
Uterine tube	Conducts the egg to the uterus; site of fertilization
Uterus	Muscular chamber where the embryo develops
Cervix	Nearly closes off the outer end of the uterus; supports the developing embryo during pregnancy
Vagina	Receptacle for semen; birth canal

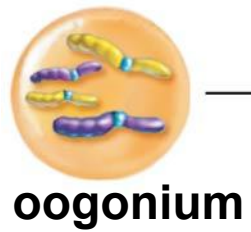


Figure 41-15 Oogenesis

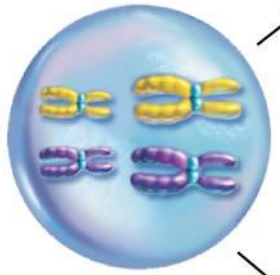
develops in the fetus  
—oogonia as early as the 6th week of embryonic development

produced monthly beginning at puberty

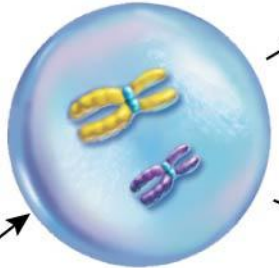
produced after fertilization



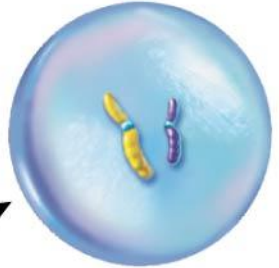
**oogonium**



**primary oocyte**



**secondary oocyte (egg)**



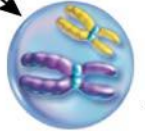
**egg**



**polar body**



**polar body**



**polar body**



**polar body**

9th through 20th weeks

—stops during prophase of meiosis I

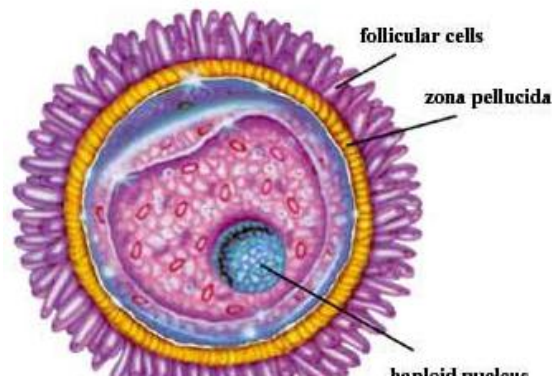


## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- ovaries (*continued*)

- The ovary produces **eggs**, **estrogen**, and **progesterone** during the menstrual cycle
  - In a mature ovary, each oocyte is surrounded by a layer of smaller cells, together making up a **follicle**
    - Follicle development and ovulation are produced by the hypothalamus, anterior pituitary, and ovary, in a roughly **28-day cycle** called the **menstrual cycle**



## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - The ovary produces eggs, estrogen, and progesterone during the menstrual cycle (*continued*)
    - A maturing **follicle** secretes increasing amounts of **estrogen**, which stimulates a surge of **LH** that causes the **primary oocyte to complete meiosis I, dividing into a single secondary oocyte and the first polar body**
      - The **polar body** is a small cell, with very little cytoplasm
      - The polar body cannot be fertilized by sperm

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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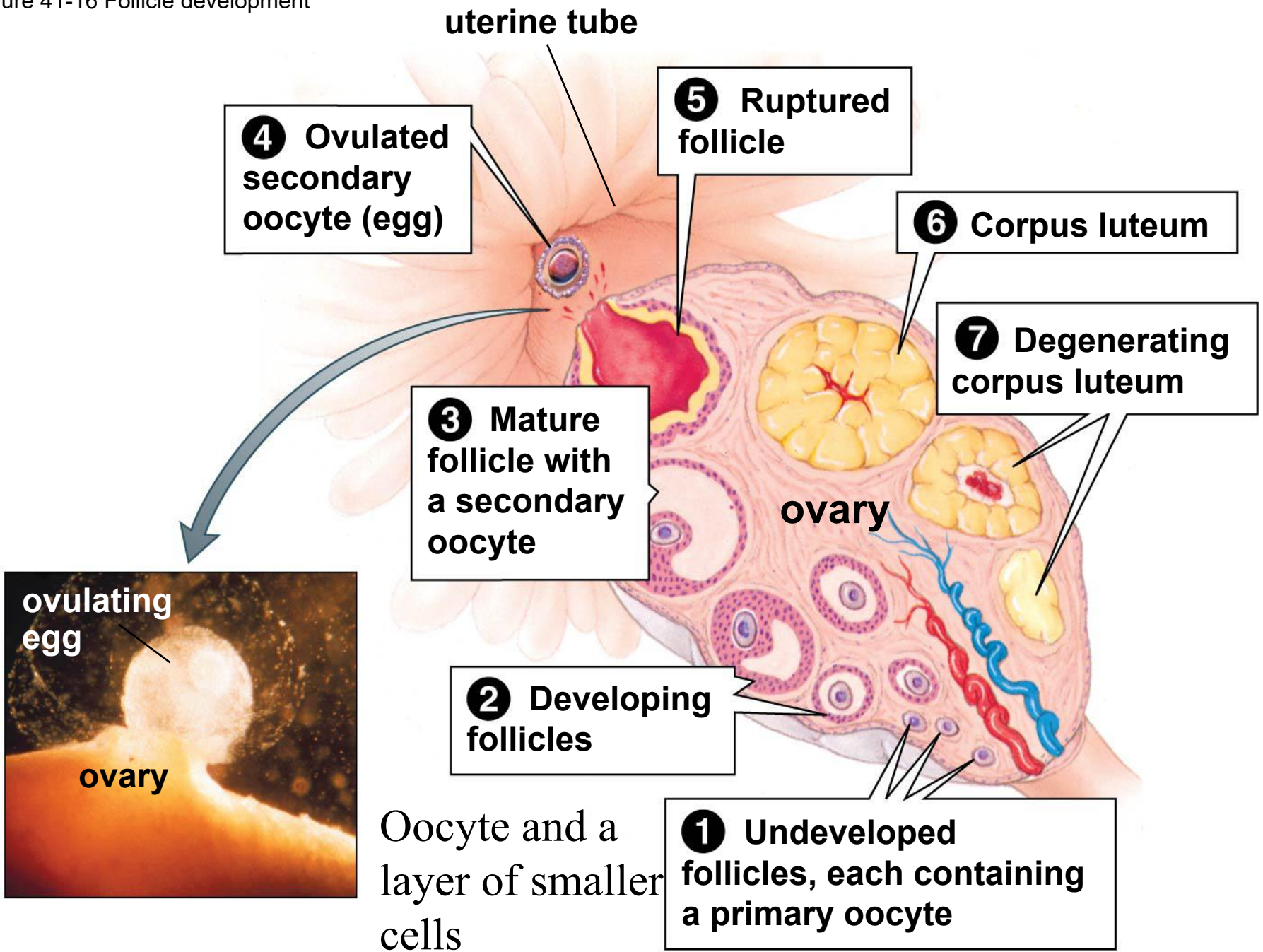
- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - The ovary produces eggs, estrogen, and progesterone during the menstrual cycle (*continued*)
    - The secondary oocyte will not undergo meiosis II unless it is fertilized
    - The surge of LH also causes ovulation, as the follicle erupts through the surface of the ovary, releasing its secondary oocyte

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - The ovary produces eggs, estrogen, and progesterone during the menstrual cycle (*continued*)
    - Some of the **follicle cells** leave the ovary with the egg, but most remain in the ovary, where they enlarge, forming a temporary gland called the **corpus luteum**
    - The corpus luteum secretes both **estrogen** and a second hormone called **progesterone**
      - If fertilization does not occur, the corpus luteum degenerates

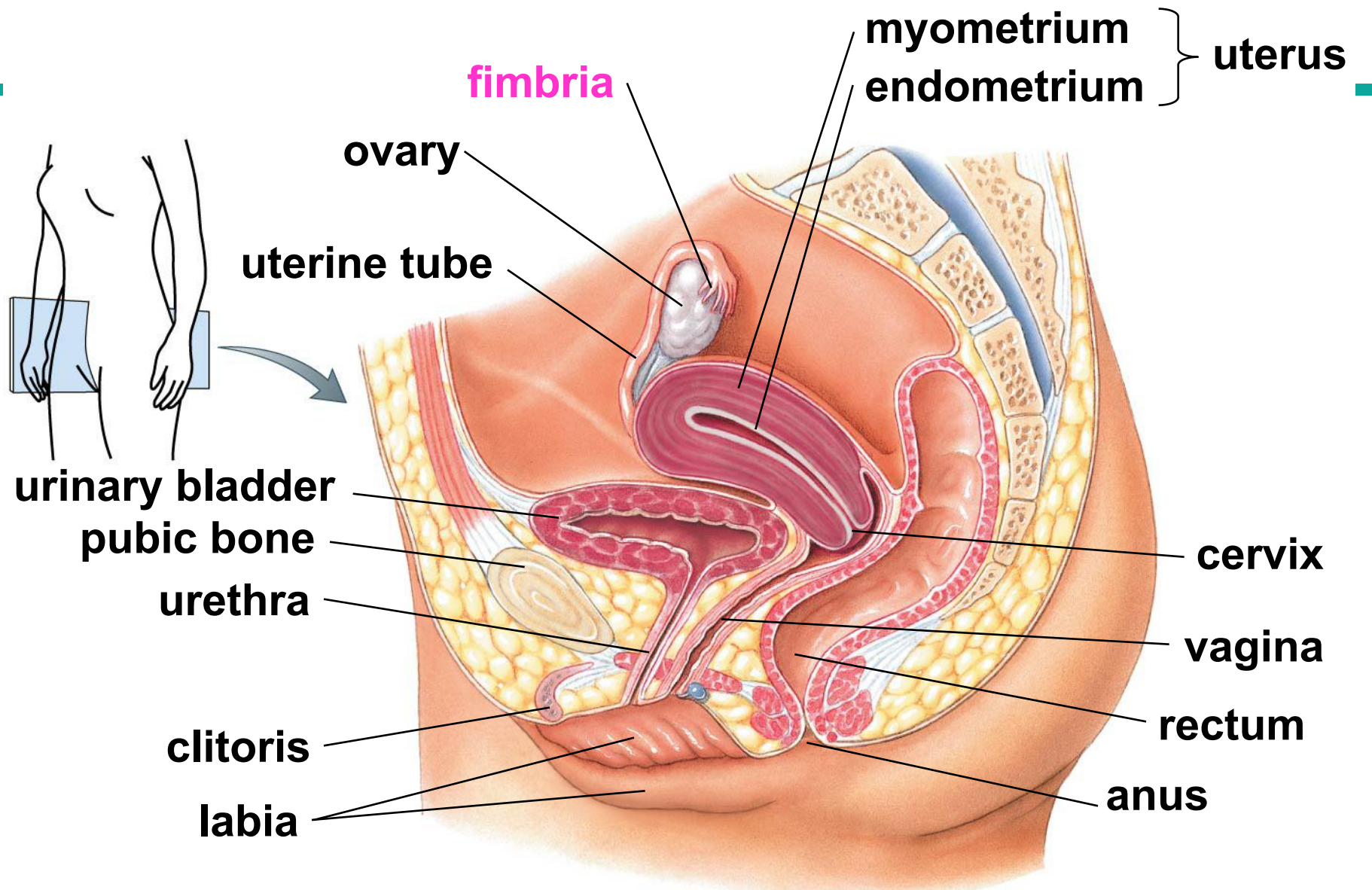
Figure 41-16 Follicle development



## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - Accessory structures include the uterine tubes, uterus, and vagina
    - Each ovary nestles within the **open end** of a **uterine tube** (also called the **oviduct** or Fallopian tube), which is fringed with ciliated “fingers” called *fimbria* that nearly surround the ovary





## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - Accessory structures include the uterine tubes, uterus, and vagina (*continued*)
    - **The cilia** create a current that sweeps the newly ovulated egg into the uterine tube
    - There, the egg may encounter sperm and be fertilized
    - **Cilia** lining the uterine tube sweep the fertilized egg down the tube and into the **uterus**

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - Accessory structures include the uterine tubes, uterus, and vagina (*continued*)
    - The wall of the uterus has two layers that correspond to its dual functions of nourishing the developing embryo and delivering a child
      - The inner lining, or **endometrium**, will form the mother's contribution to the **placenta**, the structure that transfers oxygen, carbon dioxide, nutrients, and wastes

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - Accessory structures include the uterine tubes, uterus, and vagina (*continued*)
    - The outer muscular wall of the uterus, called the **myometrium**, contracts during **childbirth**, expelling the infant out of the uterus
    - The lower end of the uterus is nearly closed off by the **cervix**, a ring of connective tissue that encircles a tiny opening

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

---

- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - Accessory structures include the uterine tubes, uterus, and vagina (*continued*)
    - The cervix holds the developing baby in the uterus and then expands during labor, permitting passage of the child
    - Beyond the cervix is the **vagina**, which opens to the outside

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

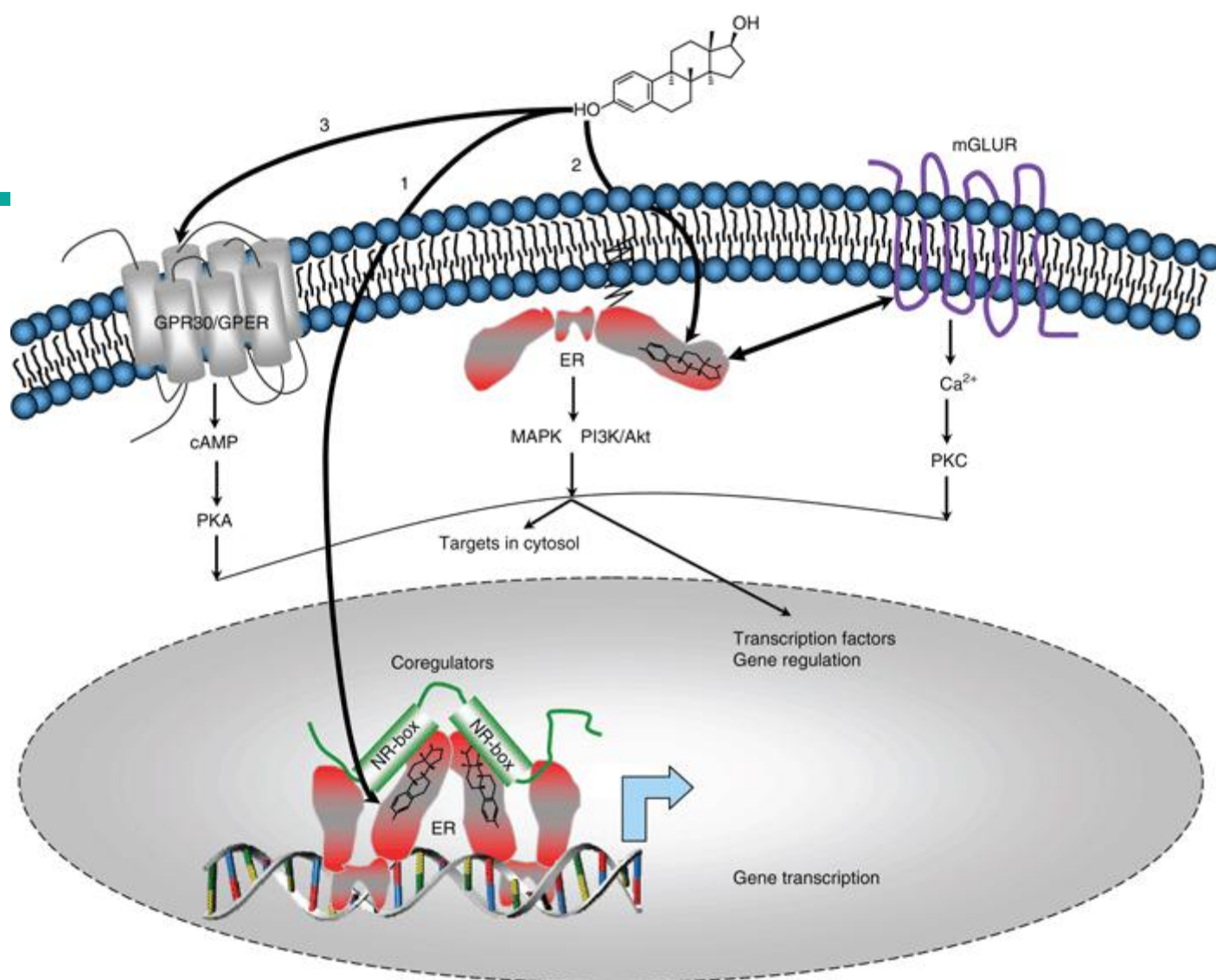
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- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - Accessory structures include the uterine tubes, uterus, and vagina (*continued*)
    - The vagina serves both as the receptacle for the penis and sperm during intercourse and as the birth canal
    - The vaginal lining is **acidic**, which reduces the **likelihood of infections**

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

---

- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - Accessory structures include the uterine tubes, uterus, and vagina (*continued*)
    - Developing follicles secrete **estrogen**, which stimulates the **endometrium** to become thicker and grow an **extensive network of blood vessels and glands**
    - After ovulation, **estrogen and progesterone** released by the corpus luteum **further stimulate** the development of the endometrium



**Schematic representation of various intracellular pathways of estrogen signaling. Pathway 1 represents the “classical” role of the estrogen receptors (ERs) as nuclear transcription factors**

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

---

- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - Accessory structures include the uterine tubes, uterus, and vagina (*continued*)
    - If **fertilization does not occur**, the corpus luteum disintegrates, estrogen and progesterone **levels fall**, and the enlarged endometrium disintegrates
    - The uterus then contracts and expels the excess endometrial tissue, a process called **menstruation**

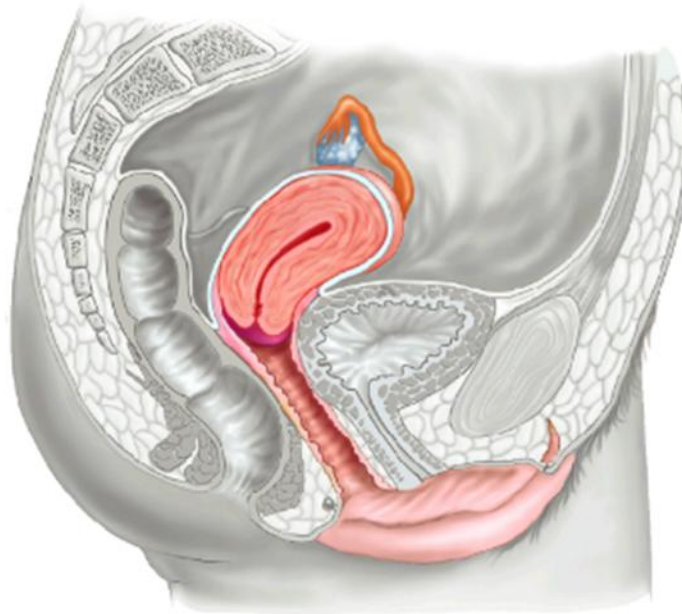


## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- The female reproductive system includes the ovaries and accessory structures (*continued*)
  - The embryo sustains its own pregnancy
    - If fertilization occurs, the embryo prevents the degeneration of the corpus luteum that would otherwise end the current menstrual cycle and start up a new one
    - Shortly after it implants in the uterus, the embryo secretes an LH-like hormone called chorionic gonadotropin (CG)

## The Female Reproductive System



Animation: The Female Reproductive System

# Gametogenesis

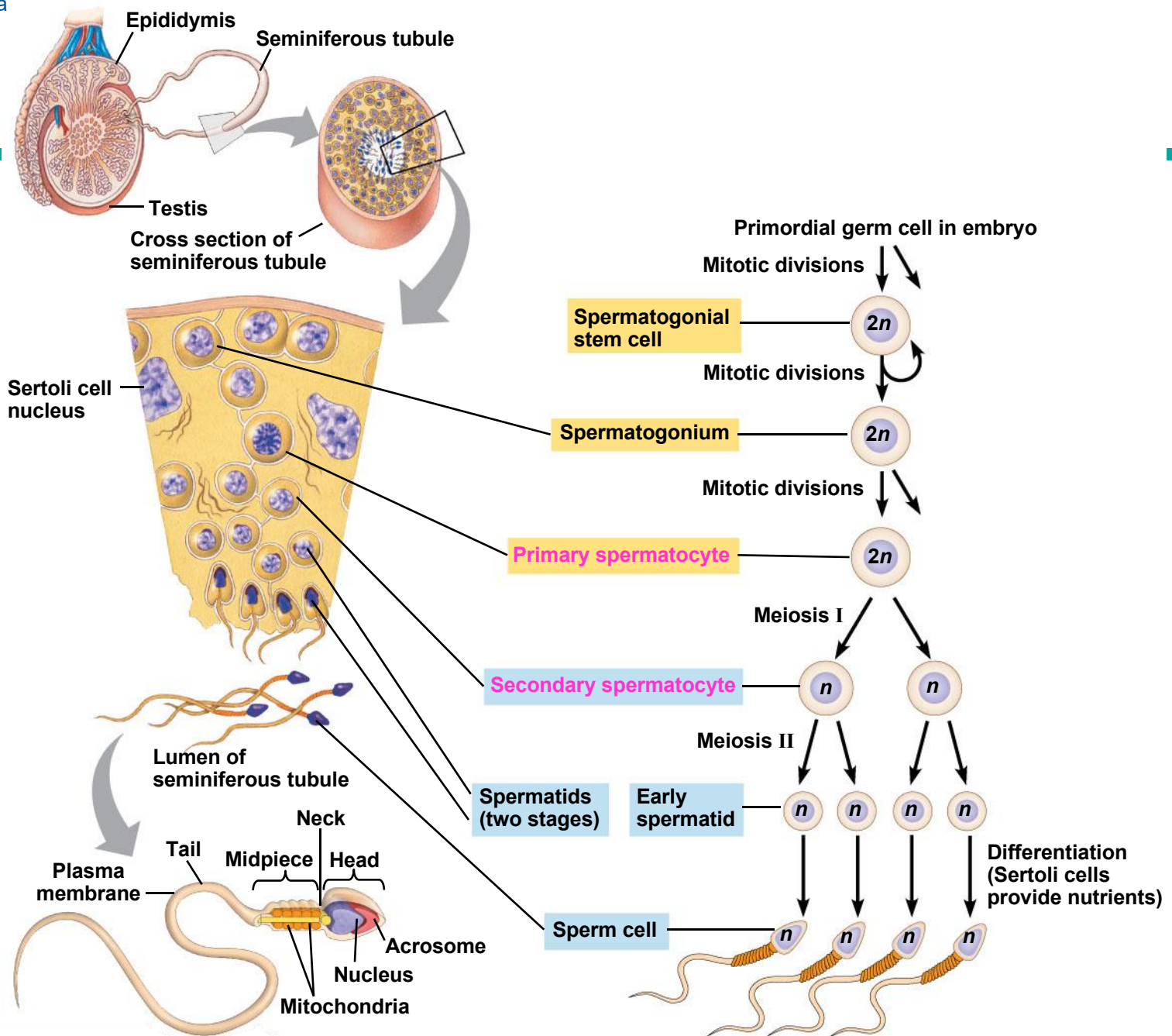
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- **Gametogenesis**, the production of gametes, differs in male and female, reflecting the distinct structure and function of their gametes
- Sperm are small and motile and must pass from male to female
- Eggs are larger and carry out their function within the female

- 
- **Spermatogenesis**, the development of sperm, is continuous and prolific (**millions of sperm** are produced per day; **each sperm takes about 7 weeks to develop**)
  - **Oogenesis**, the development of a mature egg, is a prolonged process
  - **Immature eggs** form in the female embryo but do not complete their development until **years or decades later**

- Spermatogenesis **differs** from oogenesis in three ways
  - All four products of meiosis develop into sperm while only one of the four becomes an egg
  - Spermatogenesis occurs throughout adolescence and adulthood
  - Sperm are produced continuously without the prolonged interruptions in oogenesis

Figure 46.12a



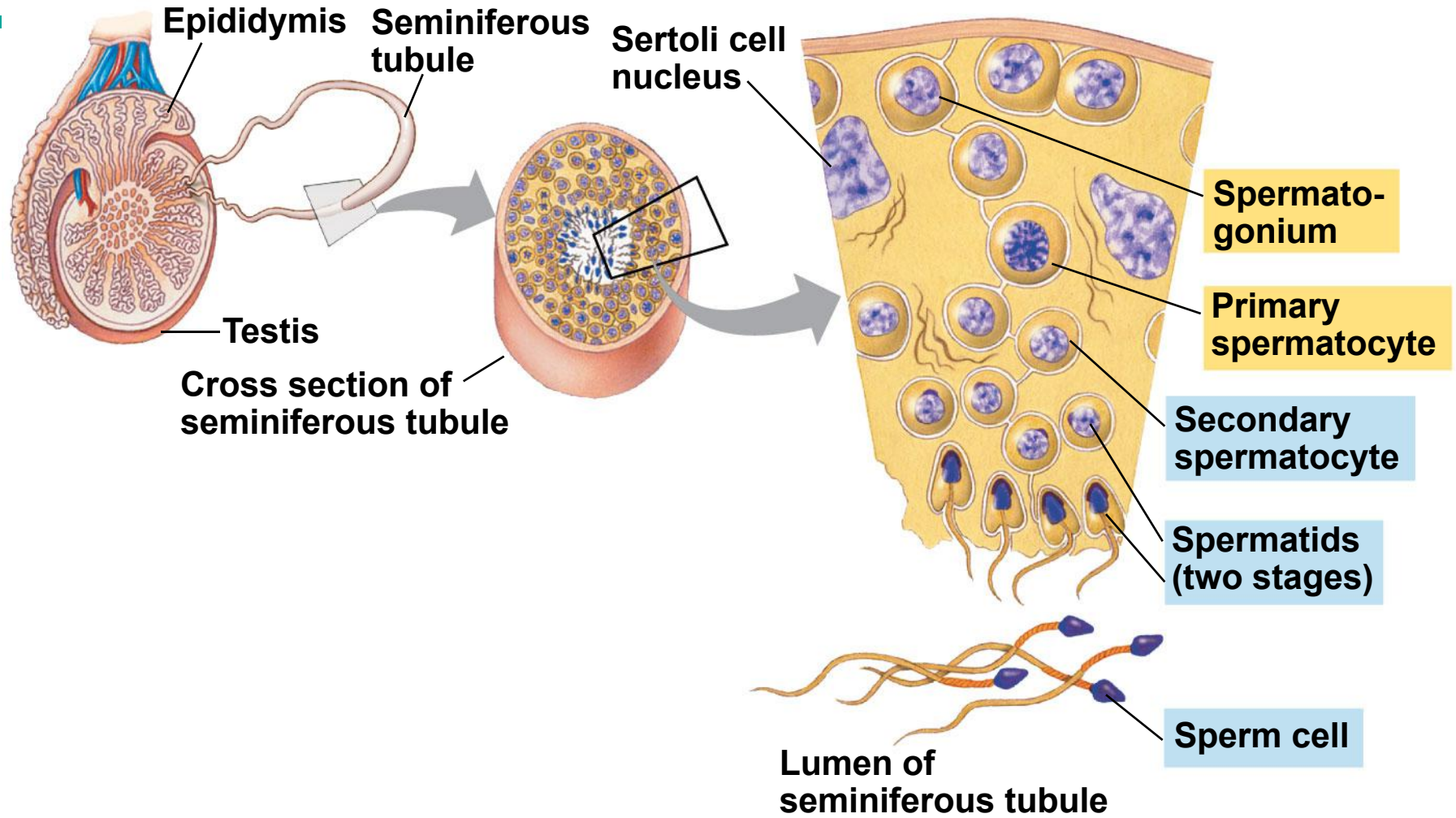
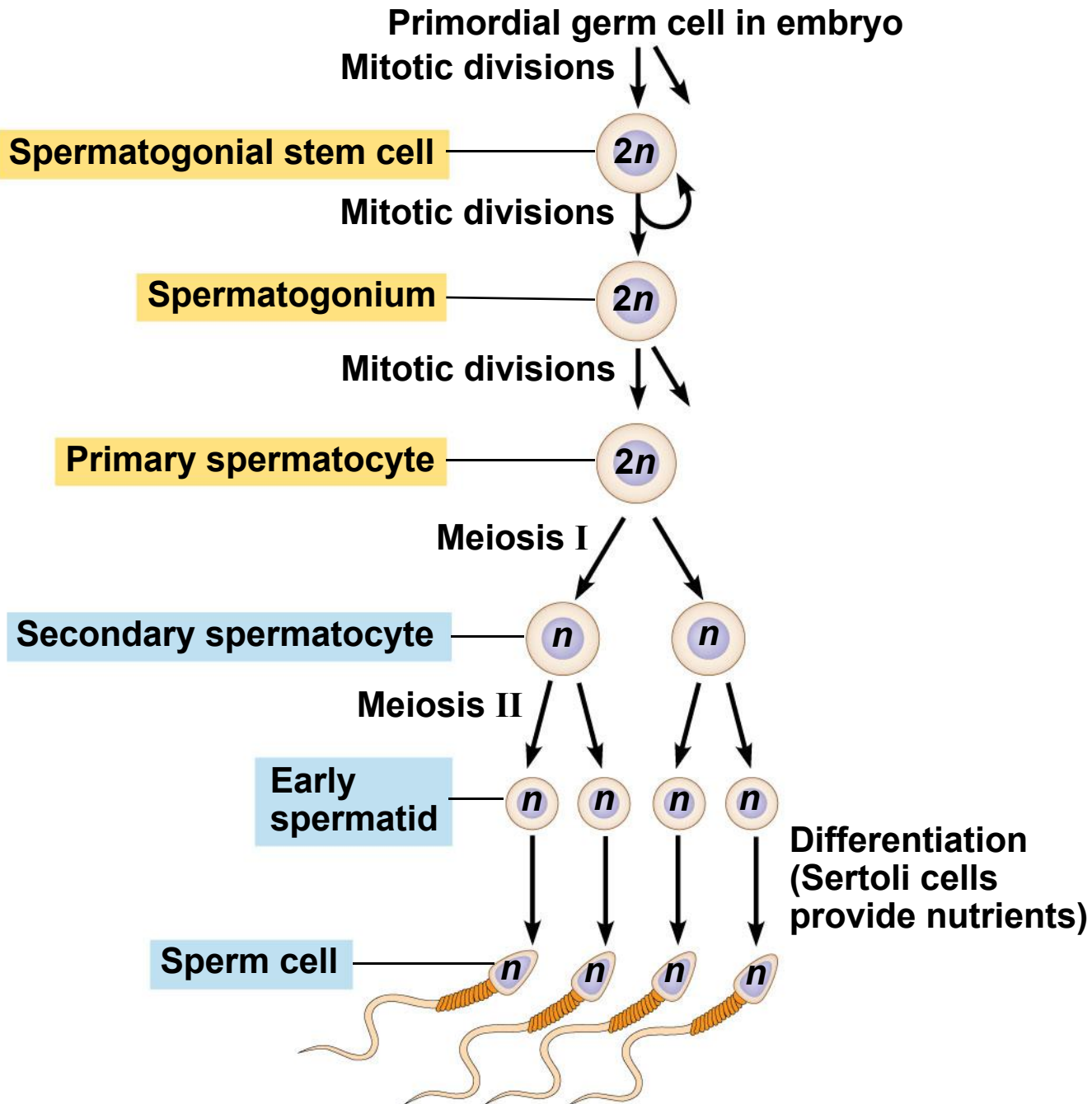
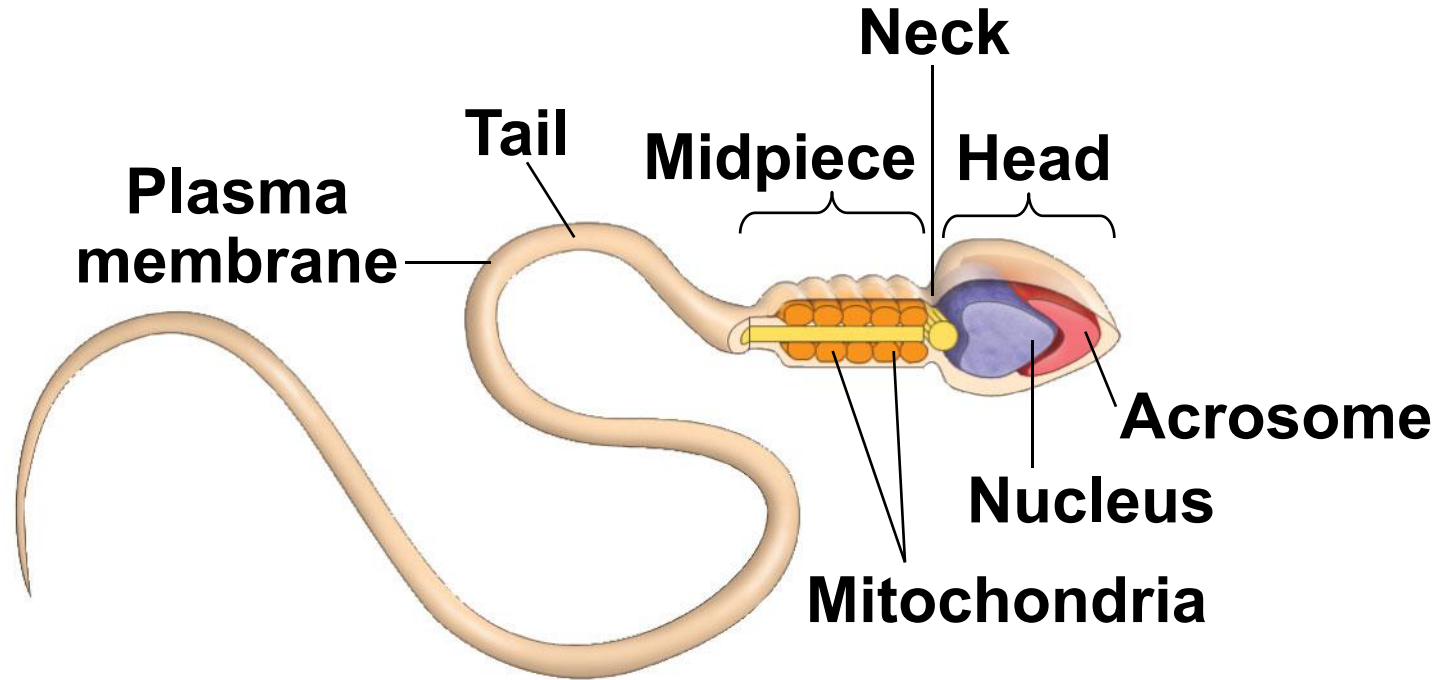


Figure 46.12ab







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Figure 46.12b

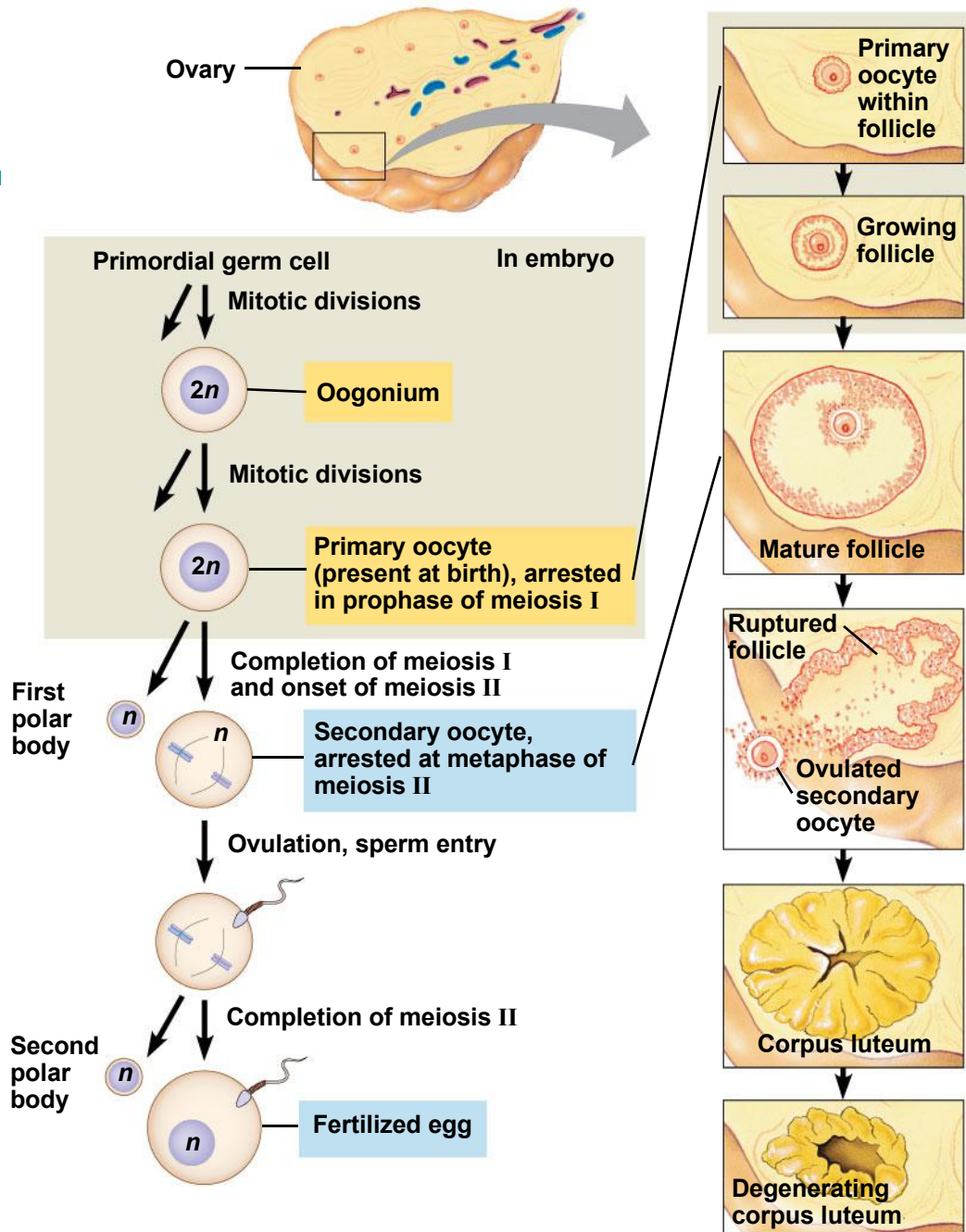


Figure 46.12ba

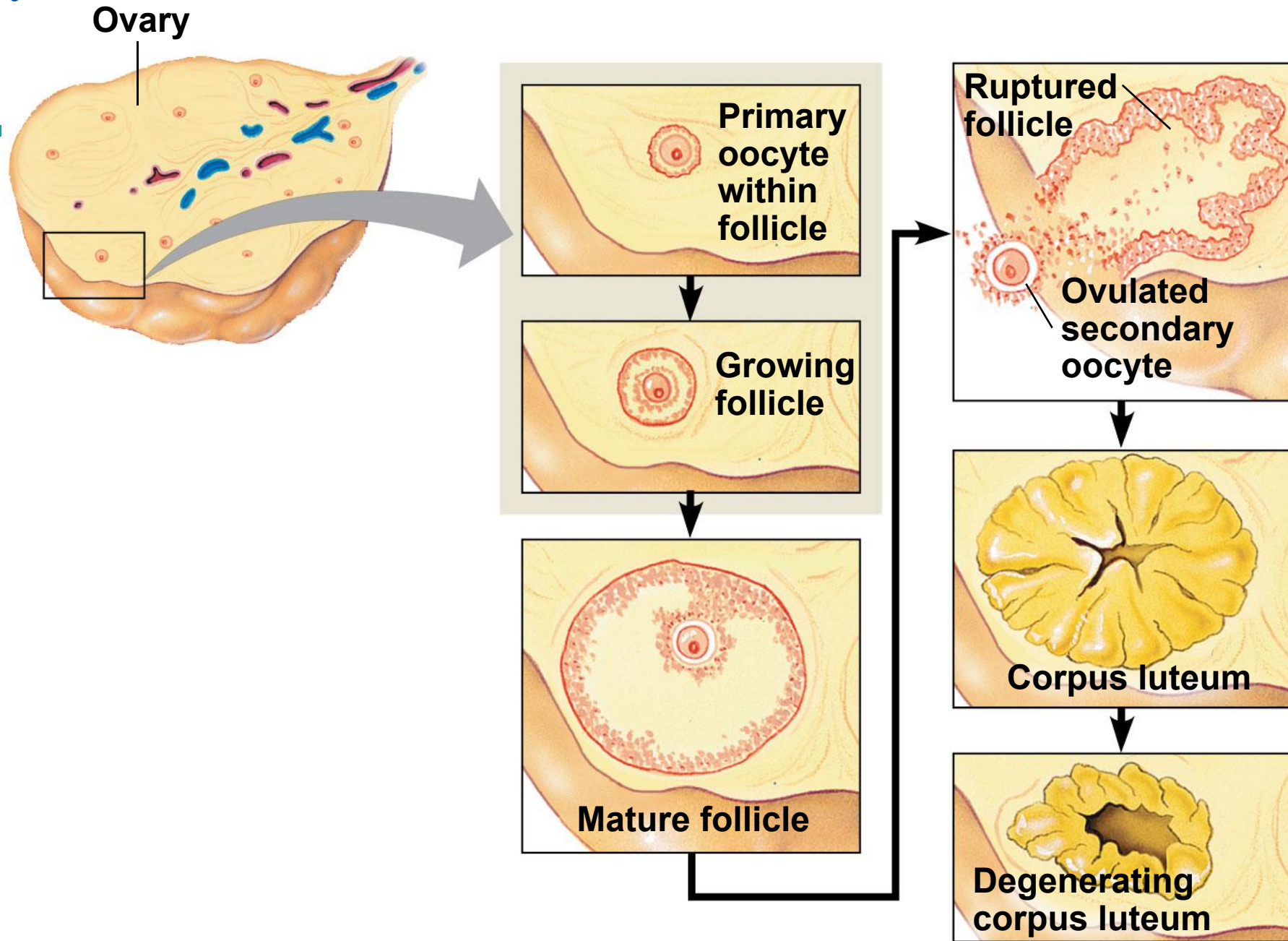
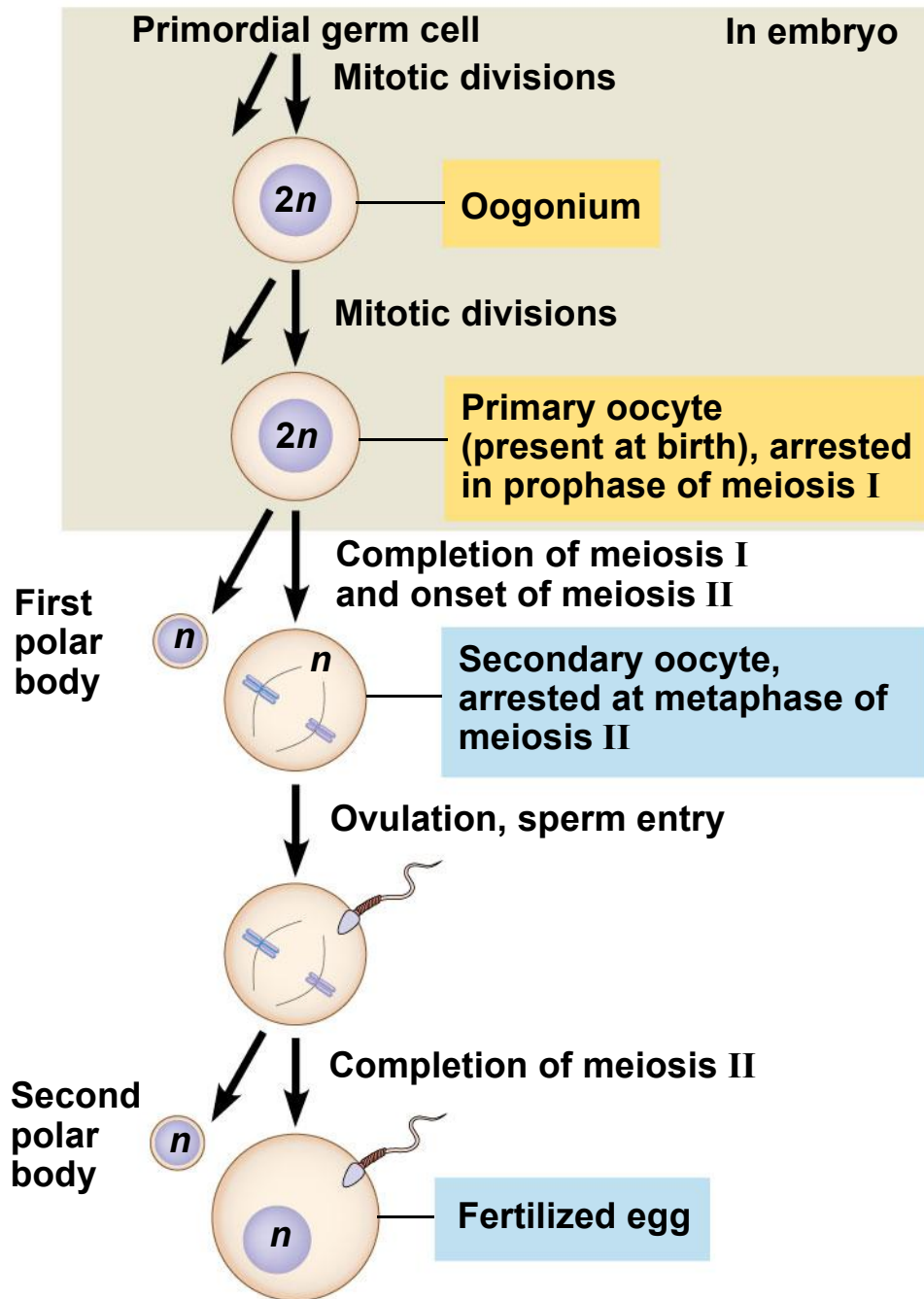


Figure 46.12bb



## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- During copulation, sperm are deposited in the vagina

A typical ejaculation consists of about 2 to 5 milliliters of semen containing about 100 million to 400 million sperm

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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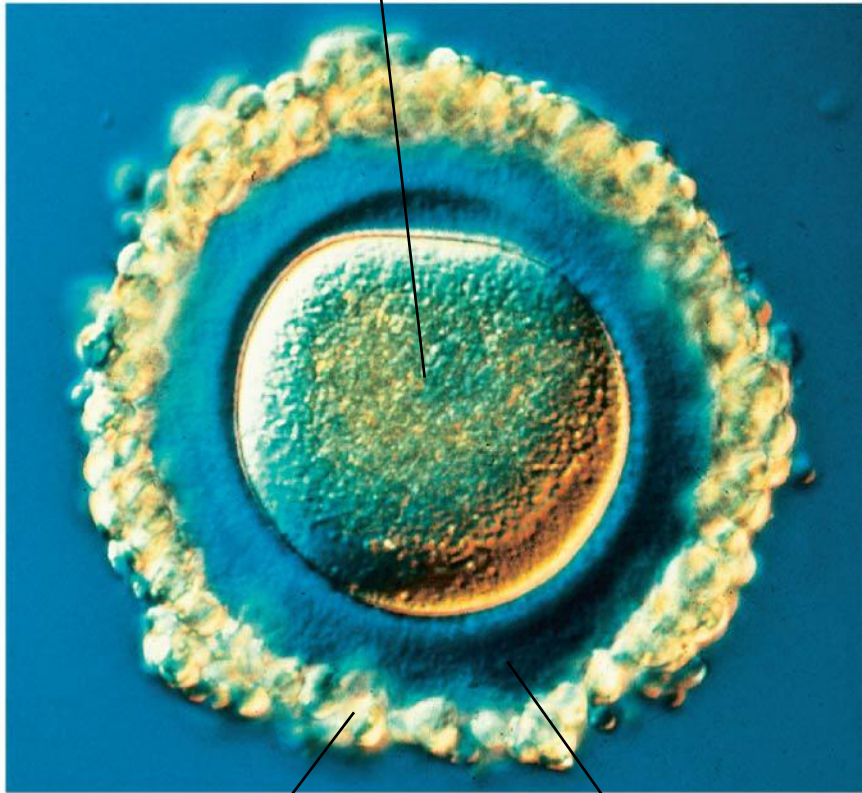
- During fertilization, the sperm and egg nuclei unite
  - **Sperm, 2 to 4 days**
  - **egg , a day or so**
  - During intercourse, the penis releases sperm into the vagina
    - The sperm move through the cervix, into the uterus, and finally, they enter the uterine tubes
    - **If copulation occurs within a day or two of ovulation, the sperm may meet an egg in one of the uterine tubes**

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- During fertilization, the sperm and egg nuclei unite  
*(continued)*

**secondary oocyte (egg)**



**corona radiata**      **zona pellucida**  
follicle cells

**(a)** An ovulated secondary oocyte



**(b)** Sperm surrounding an oocyte

**hundreds of sperm reach the egg and encircle the corona radiata**



## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

---

- During fertilization, the sperm and egg nuclei unite (*continued*)
  - Each sperm releases enzymes from its acrosome
    - These enzymes weaken both the corona radiata and the zona pellucida, allowing the sperm to wiggle through to the egg
    - If there aren't enough sperm, not enough enzyme is released, and none of the sperm will reach the egg
      - This may be the reason that natural selection had led to the ejaculation of so many sperm

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- During fertilization, the sperm and egg nuclei unite  
*(continued)*
  - When the first sperm finally contacts the egg's surface, the plasma membrane of egg and sperm fuse, and the sperm's head is drawn into the egg cytoplasm

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

---

- During fertilization, the sperm and egg nuclei unite (*continued*)
  - As the **sperm enters**, it triggers **two critical changes**
    - First, vesicles near the surface of the egg release chemicals into the zona pellucida that reinforce it and prevent additional sperm from entering
    - Second, the egg **undergoes meiosis II**, and fertilization occurs as the haploid nuclei of sperm and egg fuse, forming a diploid nucleus

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

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- During fertilization, the sperm and egg nuclei unite  
*(continued)*
  - Defects in the male or female reproductive system can prevent fertilization
    - For example, a blocked uterine tube can prevent sperm from reaching the egg
    - A man with a low sperm count may be unable to impregnate a woman through sexual intercourse because too few sperm reach the egg

## 41.2 What Are the Structures and Functions of Human Reproductive Systems?

---

- During fertilization, the sperm and egg nuclei unite  
*(continued)*
  - Today, many couples who have difficulty conceiving a child seek help through **artificial insemination** *or in vitro fertilization*



## 41.3 How Can People Prevent Pregnancy?

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- During most of human evolution, child mortality was high, and natural selection favored people who produced enough children to offset this high mortality rate
  - Today, however, most people do not need to have many children to ensure that a few will survive to adulthood
  - We nevertheless retain reproductive drives that are perhaps better suited to a more precarious existence

## 41.3 How Can People Prevent Pregnancy?

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- Historically, limiting fertility has not been easy
  - In the past, women in some cultures have tried such inventive techniques as swallowing froth from the mouth of a camel or placing crocodile dung in the vagina
- Since the 1970s, several effective techniques have been developed for **contraception**—the prevention of pregnancy
  - All other forms of birth control have possible drawbacks



## 41.3 How Can People Prevent Pregnancy?

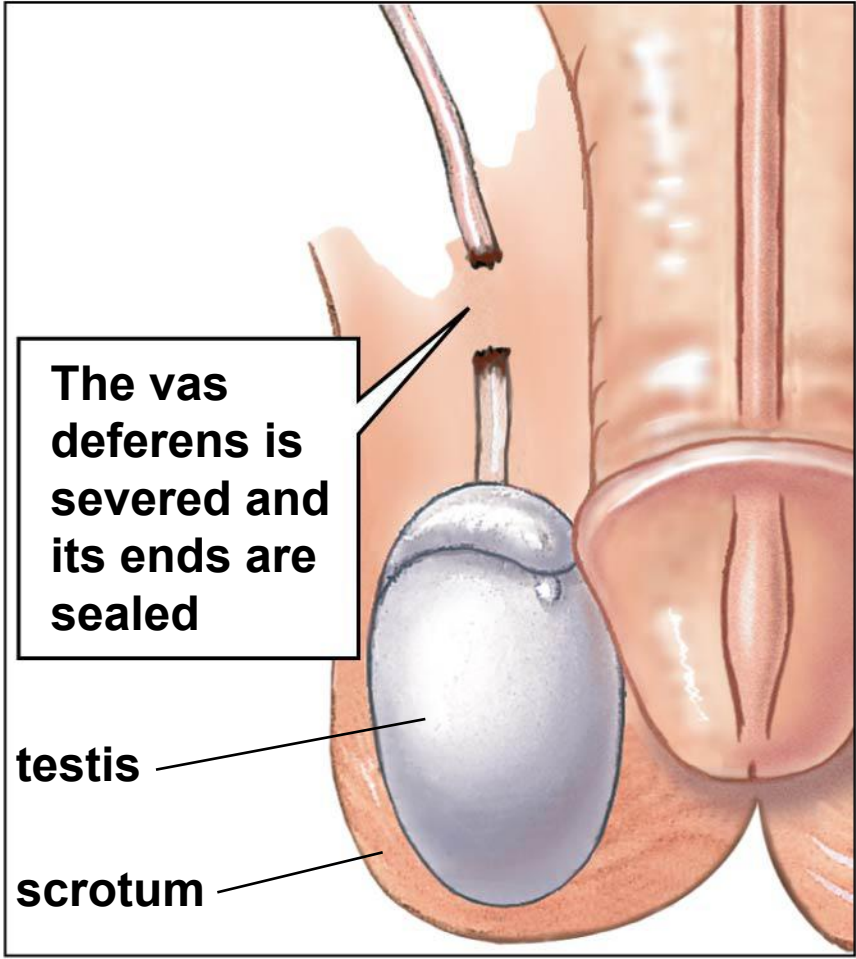
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- Sterilization provides permanent contraception
  - The most foolproof and effortless method of contraception is **sterilization**, in which the pathways through which sperm and eggs must travel are blocked or cut
    - In men the vas deferens leading from each testis can be severed and the ends tied, clamped, or sealed in an operation called a vasectomy
    - Sperm are still produced, but they cannot leave the epididymis, where they die

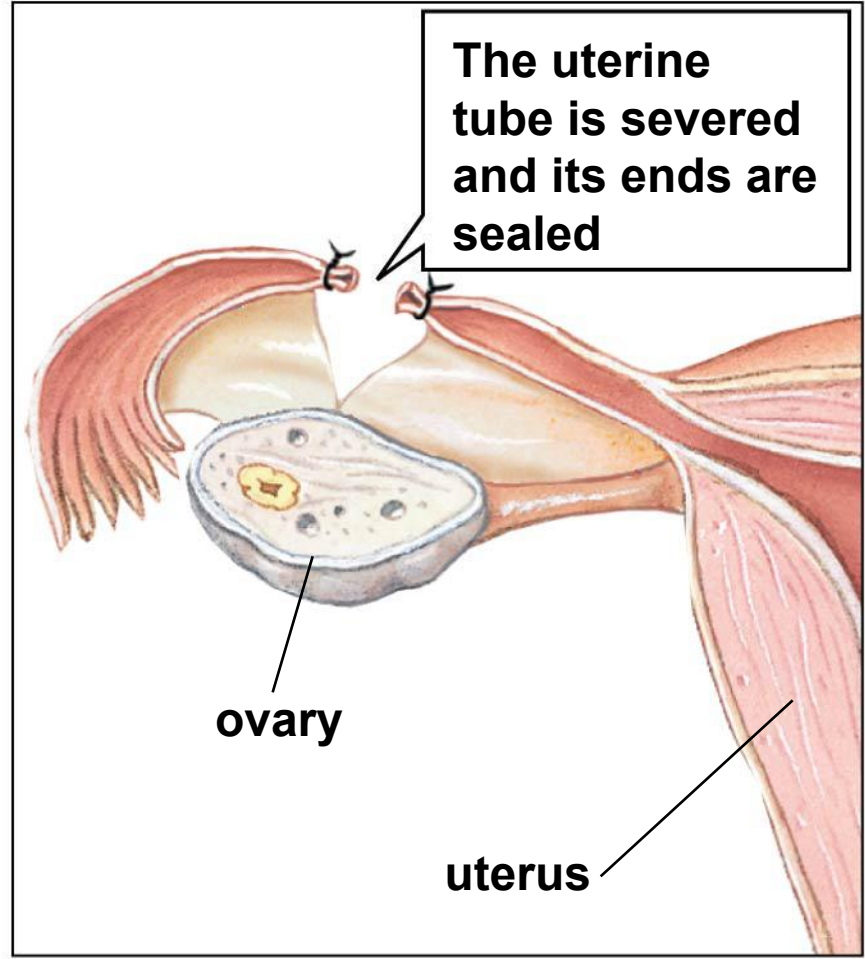
## 41.3 How Can People Prevent Pregnancy?

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- Sterilization provides permanent contraception  
*(continued)*
  - Tubal ligation renders a woman infertile by clamping or cutting her uterine tubes, and tying or sealing off the cut ends
    - Ovulation still occurs, but sperm cannot travel to the egg, nor can the egg reach the uterus
  - An alternative procedure is tubal implant
    - Tiny springs are guided through the vagina, cervix, and uterus, and inserted into each uterine tube



**(a) Vasectomy**



**(b) Tubal ligation**

## 41.3 How Can People Prevent Pregnancy?

---

- Sterilization provides permanent contraception  
*(continued)*
  - If a sterilized woman or man wishes to reverse the operation, a surgeon can attempt to reconnect the uterine tubes or vas deferens
    - About 70% to 90% of young women are able to become pregnant after their uterine tubes have been reconnected by a skilled, experienced surgeon

## 41.3 How Can People Prevent Pregnancy?

---

- Sterilization provides permanent contraception  
*(continued)*
  - Pregnancy rates, however, vary dramatically according to the following:
    - The age of the woman—older women have a lower success rate
    - The method of the original tubal ligation—higher success rates occur if the uterine tubes were clamped rather than cut or cauterized
    - Tubal implants are not readily reversible

## 41.3 How Can People Prevent Pregnancy?

---

- Sterilization provides permanent contraception  
*(continued)*
  - To reverse a vasectomy, each vas deferens is surgically reconnected
    - Sperm reappear in the ejaculate in 70% to 98% of cases, depending mostly on the skill of the surgeon
    - However, the pregnancy rate is much lower, ranging from 30% to 75%
    - The longer the interval between vasectomy and reconnection, the lower the pregnancy rate

## 41.3 How Can People Prevent Pregnancy?

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- Temporary birth control methods are readily reversible
  - Temporary methods of birth control prevent pregnancy in the immediate future, while leaving open the option of later pregnancies
  - Absolute abstinence, of course, provides complete protection against pregnancy and sexually transmitted diseases (STDs)

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible (*continued*)
  - Other temporary birth control methods fall into three categories
    1. Preventing ovulation
    2. Preventing sperm and egg from meeting
    3. Preventing implantation in the uterus
  - Birth control methods do not protect against STDs unless they prevent physical contact of the penis and vagina, as abstinence and condoms do



## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible (*continued*)
  - Synthetic hormones prevent ovulation
    - Birth control pills typically contain synthetic versions of estrogen and progesterone; minipills contain only progesterone
    - Follicle development is stimulated by FSH, and ovulation is triggered by a midcycle surge of LH

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible (*continued*)
  - Synthetic hormones prevent ovulation (*continued*)
    - The estrogen in birth control pills prevents FSH release, so follicles do not develop
      - Even if one were to develop, the progesterone in the pill would suppress the surge in LH needed for ovulation

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible (*continued*)
  - Synthetic hormones prevent ovulation (*continued*)
    - Progesterone also thickens the cervical mucus, making it more difficult for sperm to move from the vagina into the uterus, and slows down the movement of sperm and egg in the uterine tubes
    - Contraceptive patches, rings, injections, or implants of estrogen and progesterone are also available, and each device usually lasts from a few weeks to a few years

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible  
*(continued)*
  - Fertilization will not occur if sperm cannot contact the egg
    - There are several ways to prevent the encounter of sperm and egg, including what are called barrier methods

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible  
*(continued)*
  - Fertilization will not occur if sperm cannot contact the egg  
*(continued)*
    - The diaphragm and cervical cap cover the cervix, preventing the entry of sperm into the uterus
    - A female condom completely lines the vagina, and the male condom prevents sperm from being deposited in the vagina
    - Both types of condom prevent the spread of STDs

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible  
*(continued)*
  - Fertilization will not occur if sperm cannot contact the egg  
*(continued)*
    - There are ways of preventing the sperm from reaching the egg that do employ impenetrable barriers, but they are generally less effective than barrier methods
      - For example, the use of spermicide-soaked “sponge” inserted into the vagina is less effective than condoms

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible  
*(continued)*
  - Fertilization will not occur if sperm cannot contact the egg  
*(continued)*
    - Highly unreliable methods include
      - Withdrawal (removing the penis from the vagina before ejaculation)
      - Douching (attempting to wash sperm out of the vagina before they have entered the uterus)

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible (*continued*)
  - Some birth control methods work through multiple mechanisms, including preventing implantation
    - Modes of action may include
      - One or more ways of preventing ovulation
      - Hindering survival or motility of sperm
      - Preventing implantation of the embryo in the uterus



## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible (*continued*)
  - Some birth control methods work through multiple mechanisms, including preventing implantation (*continued*)
    - The intrauterine device (IUD)—a small copper or plastic loop, squiggle, or shield inserted through the cervix and into the uterus—interferes with sperm motility or survival and also alters the uterine lining, lessening the likelihood of implantation

## 41.3 How Can People Prevent Pregnancy?

---

- Temporary birth control methods are readily reversible (*continued*)
  - Some birth control methods work through multiple mechanisms, including preventing implantation (*continued*)
    - “Morning after” pills, which contain high doses of the same hormones that are used in birth control pills, act primarily by delaying or preventing ovulation, but they may also interfere with the development of the corpus luteum and prevent implantation

TABLE 41-3 Methods of Temporary Contraception

Method	Description and Mechanism	Pregnancy Rate per Year <sup>1</sup>	Protection Against STDs
None	Regular intercourse with no contraception	About 95% for women under 25 years old, declining to about 45% by age 40	None
<b>Hormonal methods that prevent ovulation</b>			
Birth control pill	Pill containing either synthetic estrogen and synthetic progesterone (combination pill) or progesterone only (minipill); taken daily	0.3% to 8%	None
Vaginal ring	Flexible plastic ring containing synthetic estrogen and progesterone, inserted into the vagina around the cervix; replaced every 4 weeks	0.3% to 8%	None
Contraceptive patch	Skin patch containing synthetic estrogen and progesterone; replaced weekly	0.1% to 8% <sup>2</sup>	None
Birth control injection	Injection of synthetic progesterone that blocks ovulation; repeated at 3-month intervals	0.1% to 3%	None
Contraceptive implant	Small plastic rod containing synthetic progesterone that blocks ovulation; replaced every 3 years	<0.1%	None

<sup>1</sup>The percentage of women becoming pregnant per year. The low numbers represent the pregnancy rate with consistent, correct contraceptive use; the higher numbers represent the pregnancy rate with more typical use that is not always consistent or correct. It is likely that many women do not report incorrect usage, so the actual failure rates with correct use may be lower.

<sup>2</sup>The patch and the pill are about equally effective; however, the patch is more likely to be used properly. The patch may be less effective in women weighing more than 200 pounds.

TABLE 41-3 Methods of Temporary Contraception

Method	Description and Mechanism	Pregnancy Rate per Year <sup>1</sup>	Protection Against STDs
<b>Methods that prevent sperm and egg from meeting</b>			
Abstinence	No sexual activity	0%	Excellent
Condom (male)	Thin latex or polyurethane sheath placed over the penis just before intercourse, preventing sperm from entering the vagina; more effective when used in conjunction with spermicide	2% to 15%	Good
Condom (female)	Lubricated polyurethane pouch inserted into the vagina just before intercourse, preventing sperm from entering the cervix; more effective when used in conjunction with spermicide	5% to 21%	Good (probably about the same as a male condom)
Sponge	Domed disposable sponge containing spermicide, inserted in the vagina up to 24 hours before intercourse	9% to 20% (failure rates double after giving birth)	Poor
Diaphragm or cervical cap	Reusable, flexible, domed rubber-like barriers; spermicide is placed within the dome, and the diaphragm (larger) or cap (smaller) is fitted over the cervix just before intercourse	6% to 20%	Poor
Spermicide	Sperm-killing foam is placed in the vagina just before intercourse, forming a chemical barrier to sperm	16% to 29%	Probably none
Rhythm	Measuring the time since the last menstruation, or changes in body temperature and cervical mucus, to estimate the time of ovulation so that intercourse can be avoided during the fertile period	4% to 25% (rarely performed correctly)	None

<sup>1</sup>The percentage of women becoming pregnant per year. The low numbers represent the pregnancy rate with consistent, correct contraceptive use; the higher numbers represent the pregnancy rate with more typical use that is not always consistent or correct. It is likely that many women do not report incorrect usage, so the actual failure rates with correct use may be lower.

TABLE 41-3 Methods of Temporary Contraception

Method	Description and Mechanism	Pregnancy Rate per Year <sup>1</sup>	Protection Against STDs
<b>Methods with multiple actions</b>			
IUD (intrauterine device)	Small plastic device treated with hormones or copper and inserted through the cervix into the uterus	0.1% to 1%	None
"Morning after" pill (emergency contraception)	Concentrated dose of the hormones in birth control pills, taken within 72 hours after intercourse	10% to 40% (less effective the later the pill is taken after intercourse)	None

<sup>1</sup>The percentage of women becoming pregnant per year. The low numbers represent the pregnancy rate with consistent, correct contraceptive use; the higher numbers represent the pregnancy rate with more typical use that is not always consistent or correct. It is likely that many women do not report incorrect usage, so the actual failure rates with correct use may be lower.

## 41.3 How Can People Prevent Pregnancy?

---

- Male birth control methods are under development
  - Most birth control techniques are designed for use by women
  - There are three major reasons for this
    - First, the woman, not the man, becomes pregnant, bears the associated health risks of the pregnancy and childbirth, and usually plays a larger role in child care than men do

## 41.3 How Can People Prevent Pregnancy?

---

- Male birth control methods are under development  
*(continued)*
  - Most birth control techniques are designed for use by women *(continued)*
  - There are three major reasons for this *(continued)*
    - Second, it was relatively simple to design “use it and forget about it” birth control methods for women, including birth control pills and intrauterine devices
    - Third, opinion surveys indicate that a significant number of men, often more than 25%, claim that they would never use hormonal birth control methods

## 41.3 How Can People Prevent Pregnancy?

---

- Male birth control methods are under development  
*(continued)*
  - Nevertheless, researchers are working on male contraception
  - The options currently under investigation include
    - Reversible plugs injected into the vas deferens
    - Substances administered by injection that block the action of GnRH or other pituitary hormones, thus preventing sperm from being produced



## 41.3 How Can People Prevent Pregnancy?

---

- Male birth control methods are under development  
*(continued)*
  - The options currently under investigation include  
*(continued)*
    - Vaccines that cause an immune response against sperm or other essential components of male reproduction

## 41.3 How Can People Prevent Pregnancy?

---

- Male birth control methods are under development  
*(continued)*
  - All of these methods require injections or minor surgery
  - Human trials of the hormonal methods generally give only 80% to 90% effectiveness, substantially lower than hormonal birth control in women

## 41.3 How Can People Prevent Pregnancy?

---

- Male birth control methods are under development  
*(continued)*
  - The development and marketing of male contraceptives are hindered by
    - Lack of male acceptance
    - Lower effectiveness than many female birth control methods
    - Requirement of injection or minor surgery for many methods
  - The widespread availability of male contraceptives is still years away