Chapter 46

Animal Reproduction

PowerPoint® Lecture Presentations for

Biology

Eighth Edition

Neil Campbell and Jane Reece

Lectures by Chris Romero, updated by Erin Barley with contributions from Joan Sharp

Key concepts

Reproduction system ensures eggs and sperms meet successfully, and the zygotes develop properly.

Each earthworm produces sperm and eggs; in a few weeks, new worms will hatch from fertilized eggs

Fig. 46-1

Concept 46.1: Both asexual and sexual reproduction occur in the animal kingdom

- **Sexual reproduction** is the creation of an offspring by fusion of a male gamete (**sperm**) and female gamete (**egg**) to form a **zygote**
- **Asexual reproduction** is creation of offspring without the fusion of egg and sperm

Mechanisms of Asexual Reproduction

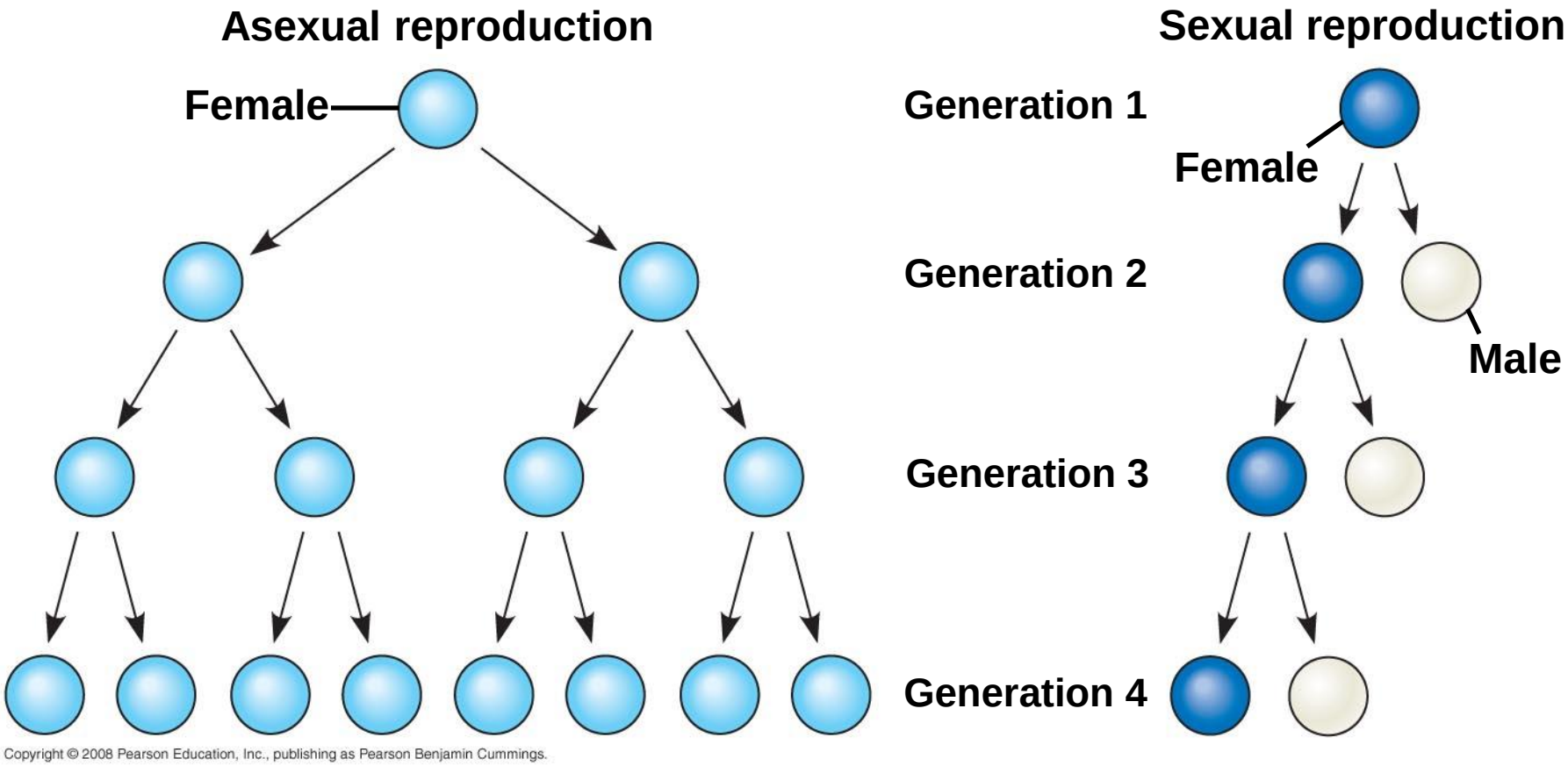
- Many invertebrates reproduce asexually by **fission**, separation of a parent into two or more individuals of about the same size
- In **budding**, new individuals arise from outgrowths of existing ones
- **Fragmentation** is breaking of the body into pieces, some or all of which develop into adults
- **Parthenogenesis** is the development of a new individual from an unfertilized egg

Fig. 46-2

Asexual reproduction of a sea anemone

Fig. 46-3

Sexual females have half as many daughters as asexual females; this is the “twofold cost” of sexual reproduction



- Sexual reproduction results in variation, 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

Origins of Genetic Variation Among Offspring (Chapter 13)

- The behavior of chromosomes during meiosis and fertilization is responsible for most of the variation that arises in each generation
- Three mechanisms contribute to genetic variation:
  - Independent assortment of chromosomes
  - Crossing over
  - Random fertilization

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Reproductive Cycles and Patterns

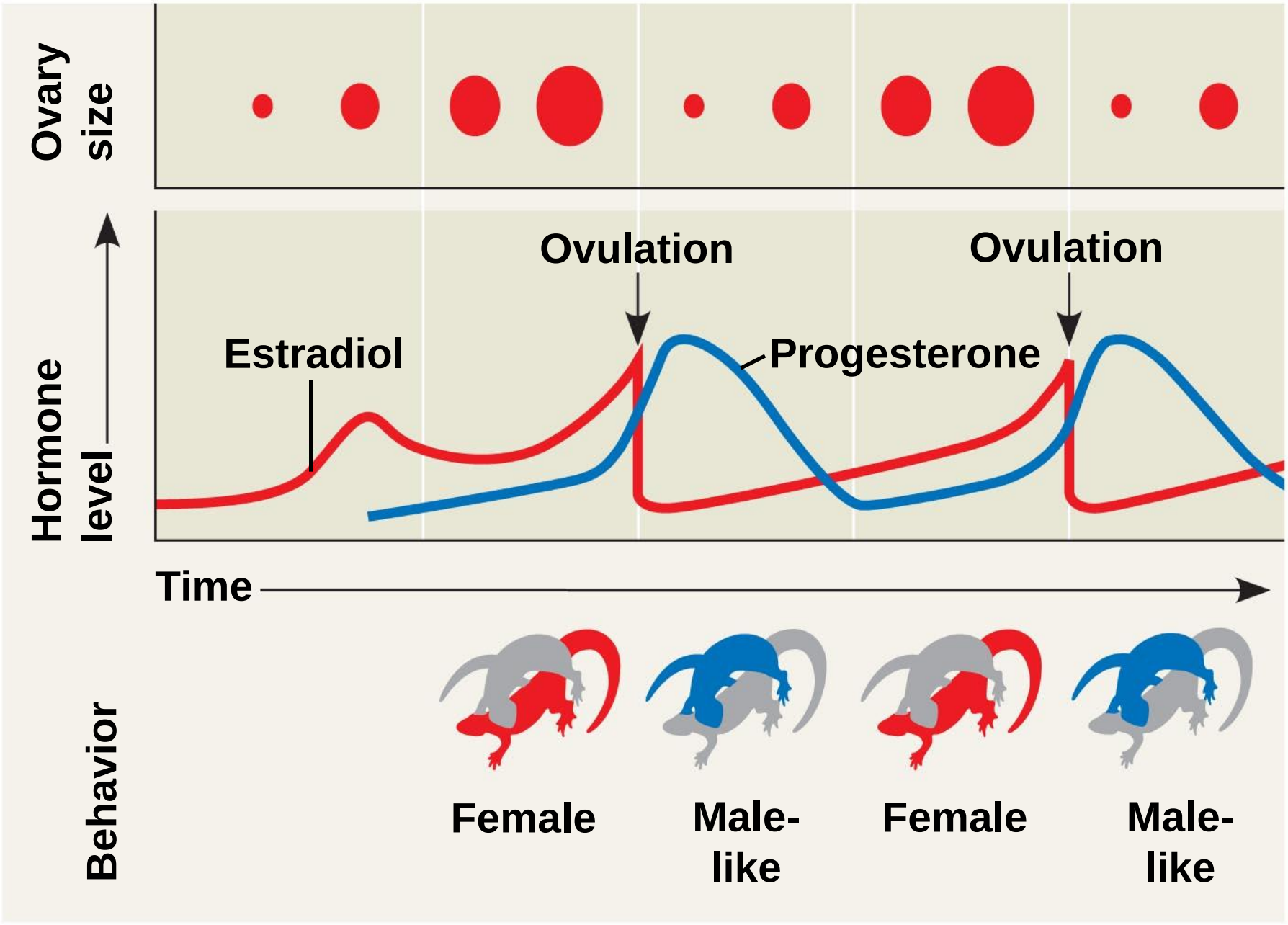
- **Ovulation** is the release of mature eggs at the midpoint of a female cycle
- Most animals exhibit reproductive cycles related to changing seasons
- Reproductive cycles are controlled by hormones and environmental cues
- Animals may reproduce asexually or sexually, or they may alternate these methods

Asexual whiptail lizards are descended from a sexual species, and females still exhibit mating behaviors

parthenogenetic lizards

Fig. 46-4a

Fig. 46-4b



- Sexual reproduction is a special problem for organisms that seldom encounter a mate
- One solution is **hermaphroditism**, in which each individual has male and female reproductive systems
- Some hermaphrodites can self-fertilize
- Individuals of some species undergo sex reversals

In external fertilization, eggs shed by the female are fertilized by sperm in the external environment

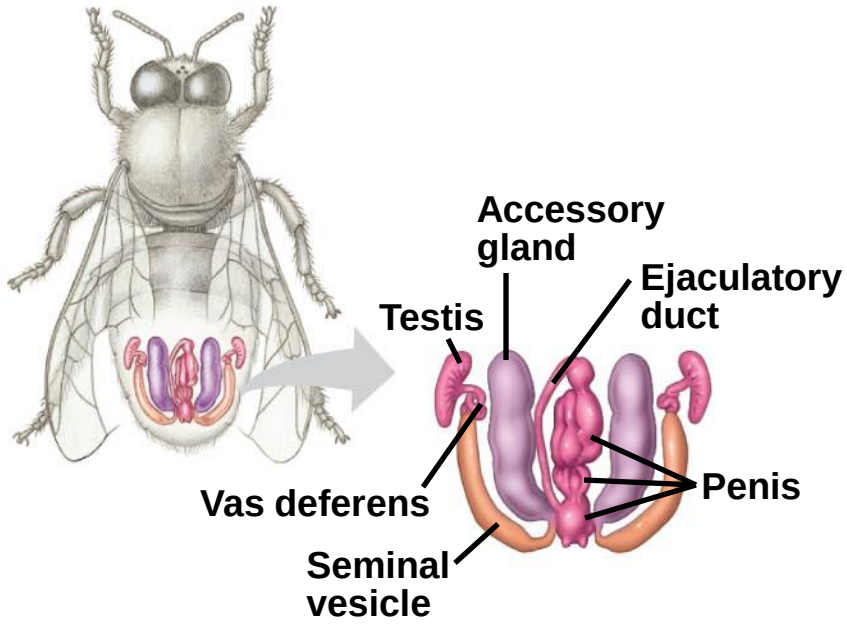
Fig. 46-5

Parental care in an invertebrate

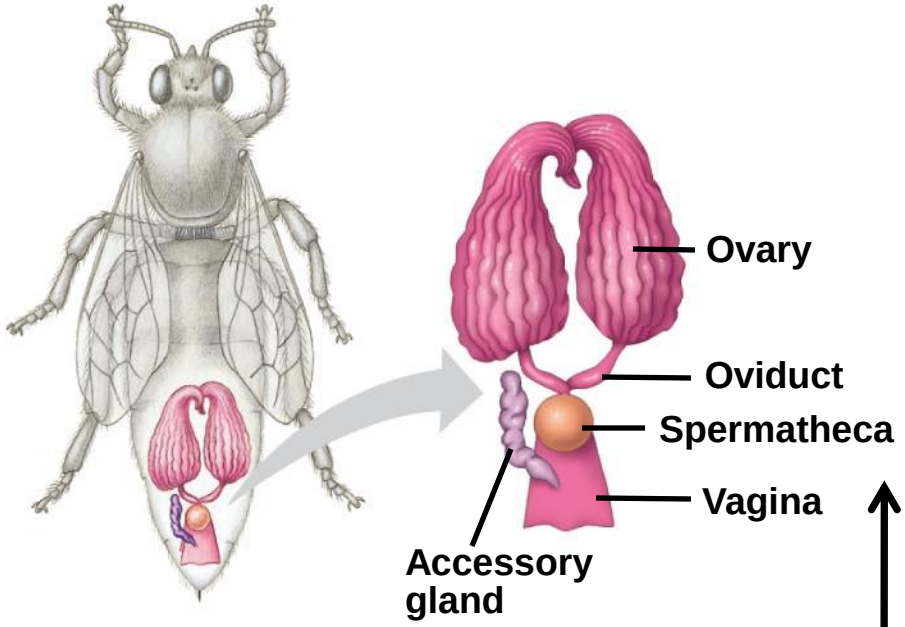
Fig. 46-6

Fig. 46-7

Insect reproductive anatomy



(a) Male honeybee (drone)



(b) Female honeybee (queen)

In many insects, the female has a **spermatheca** in which sperm is stored during copulation

Fig. 46-8

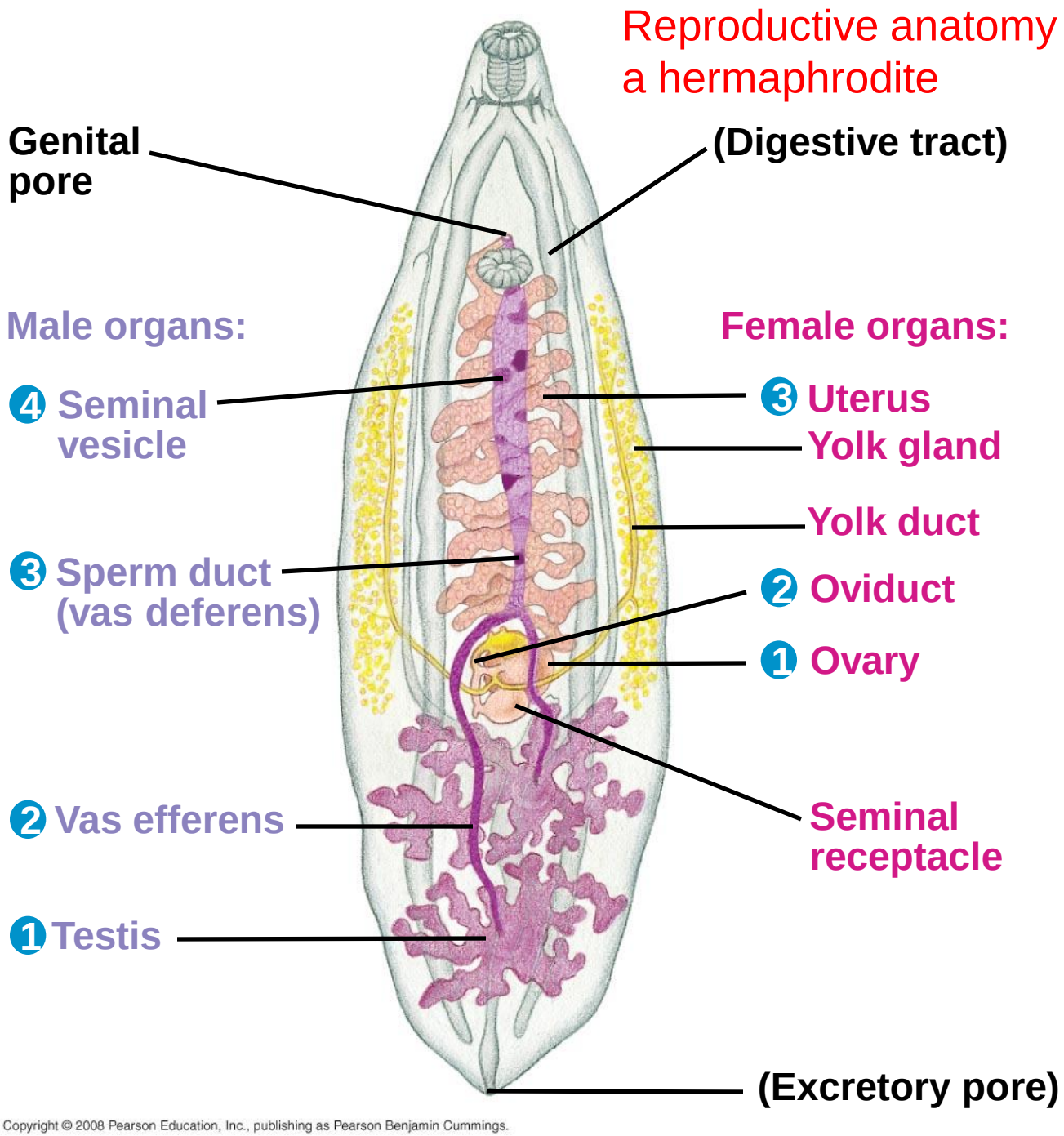


Fig. 46-9

RESULTS

Why is sperm usage biased when female fruit flies mate twice?

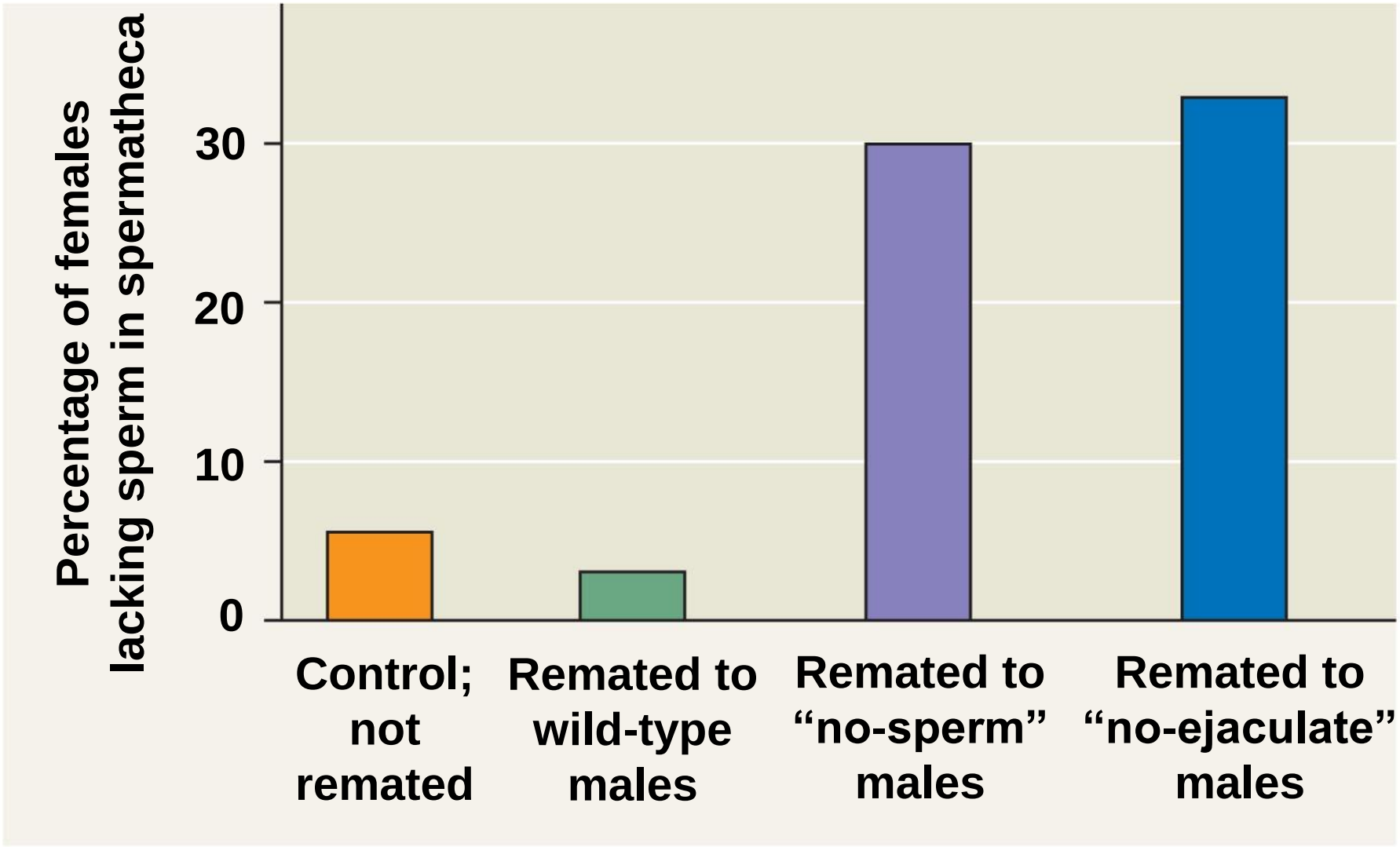
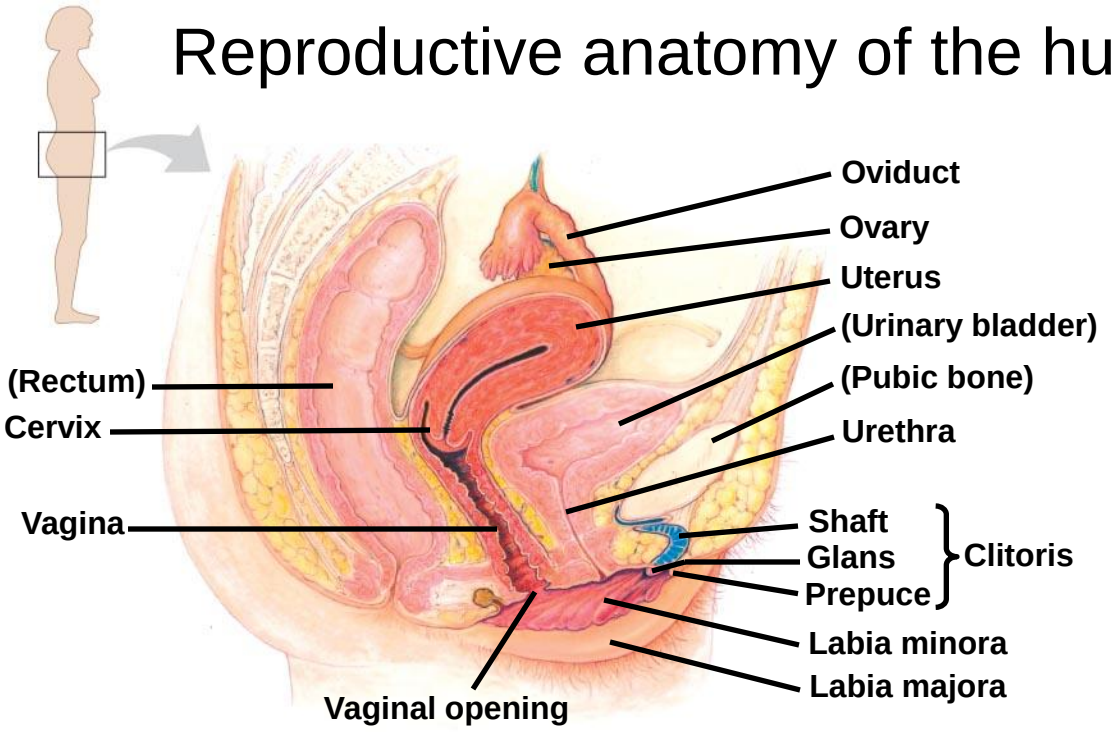


Fig. 46-10

Reproductive anatomy of the human female



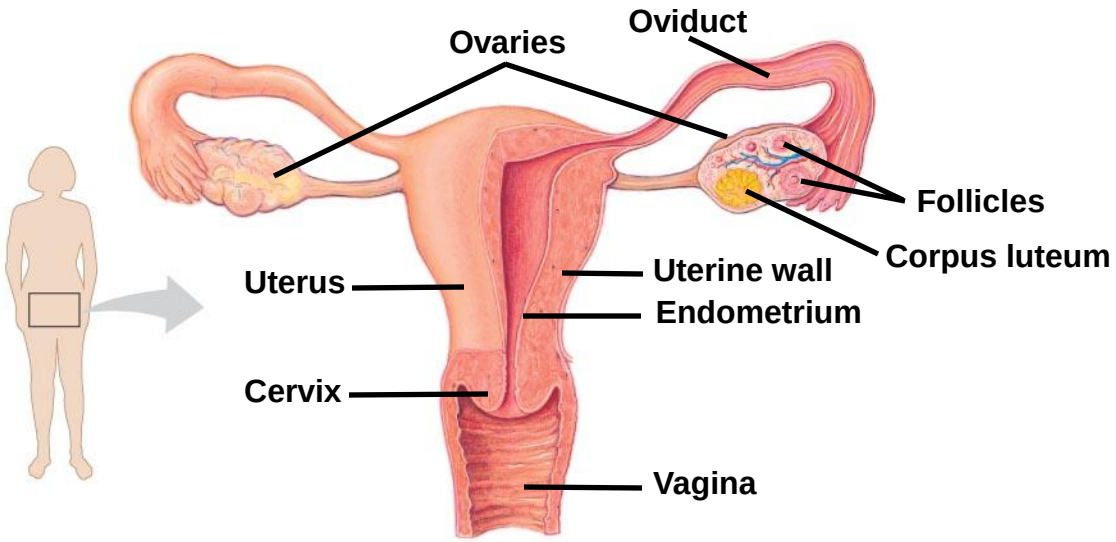


Fig. 46-11

Reproductive anatomy of the human male

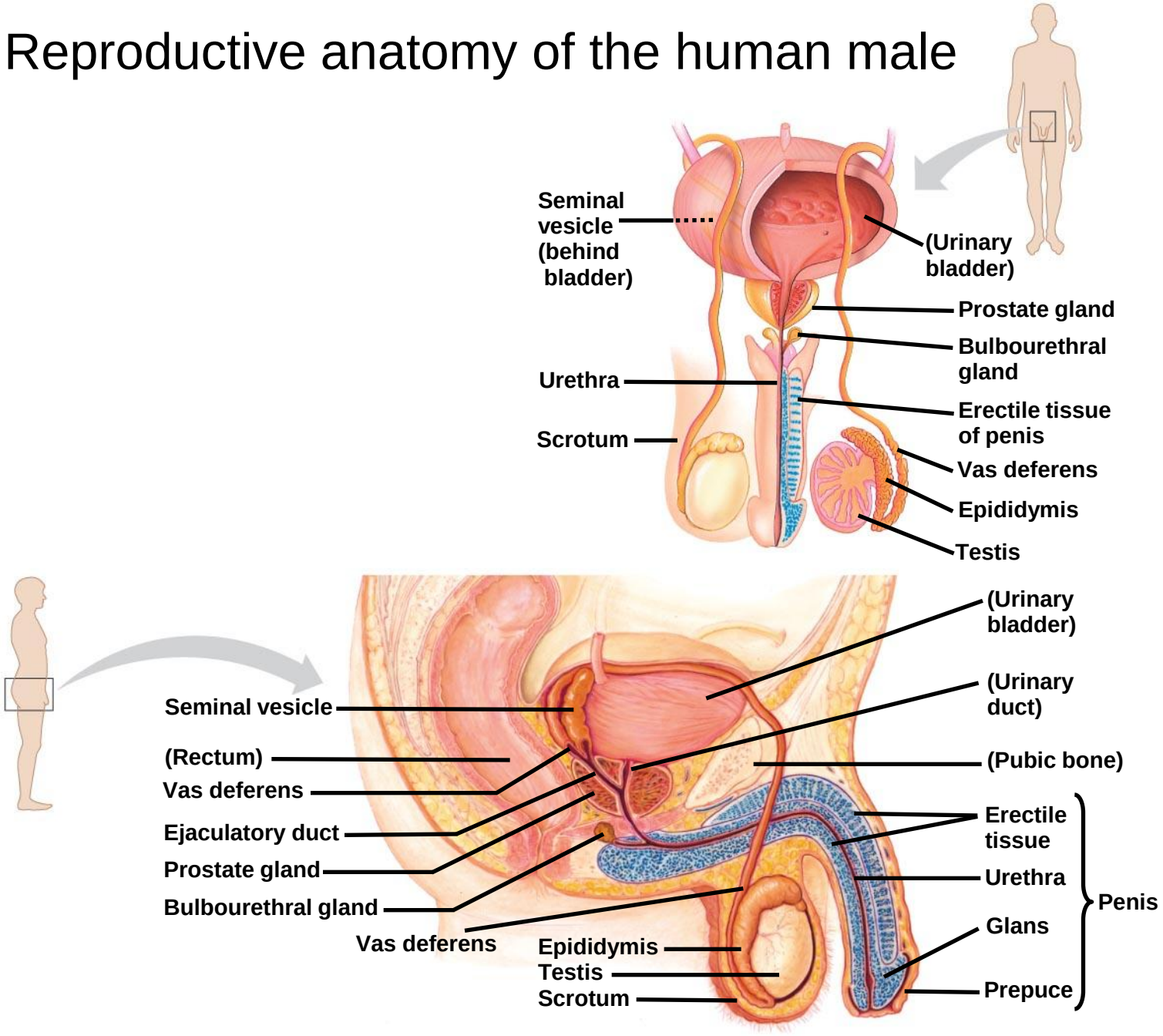


Fig. 46-12b

Sperm are small and motile and are produced throughout the life of a sexually mature male

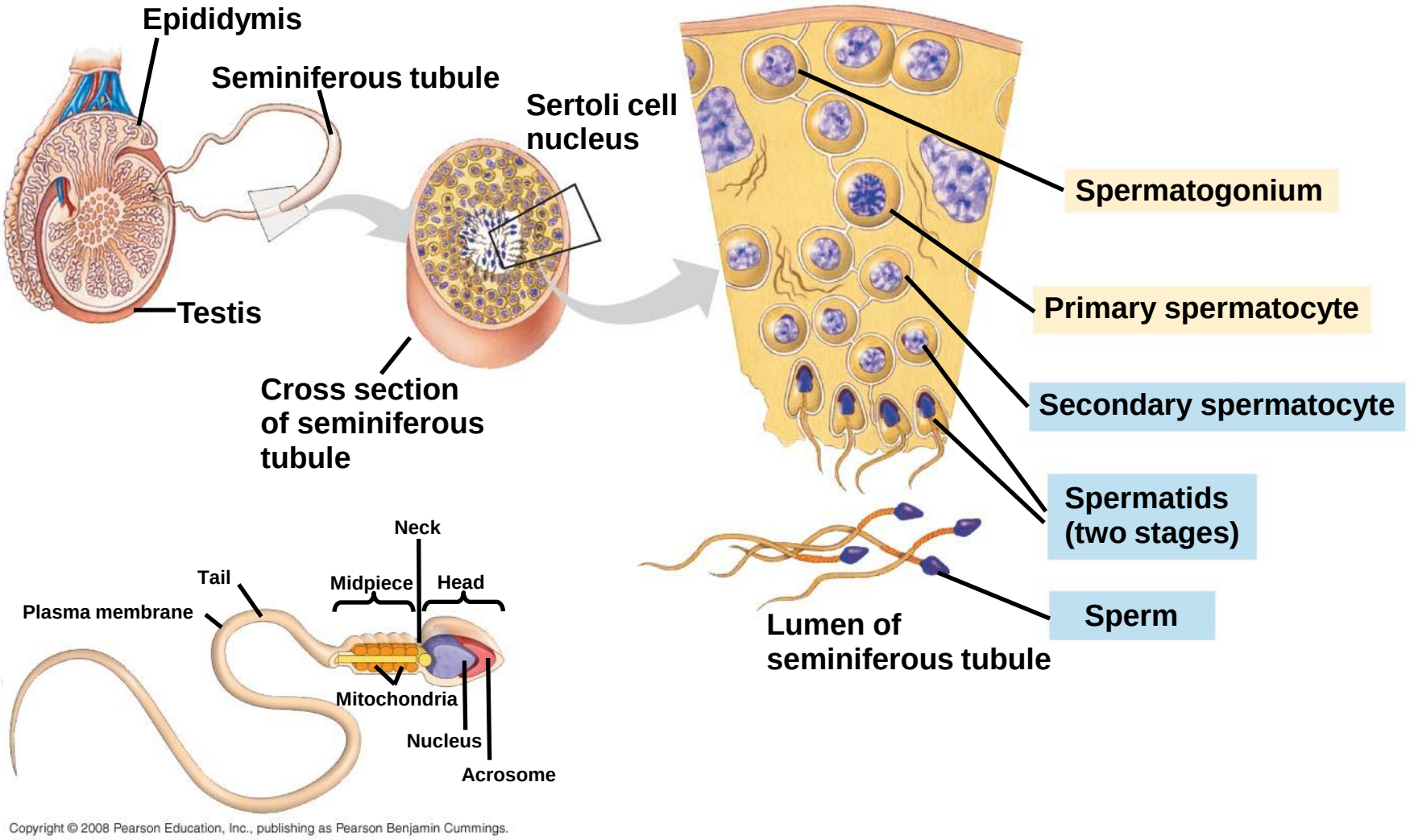


Fig. 46-12c

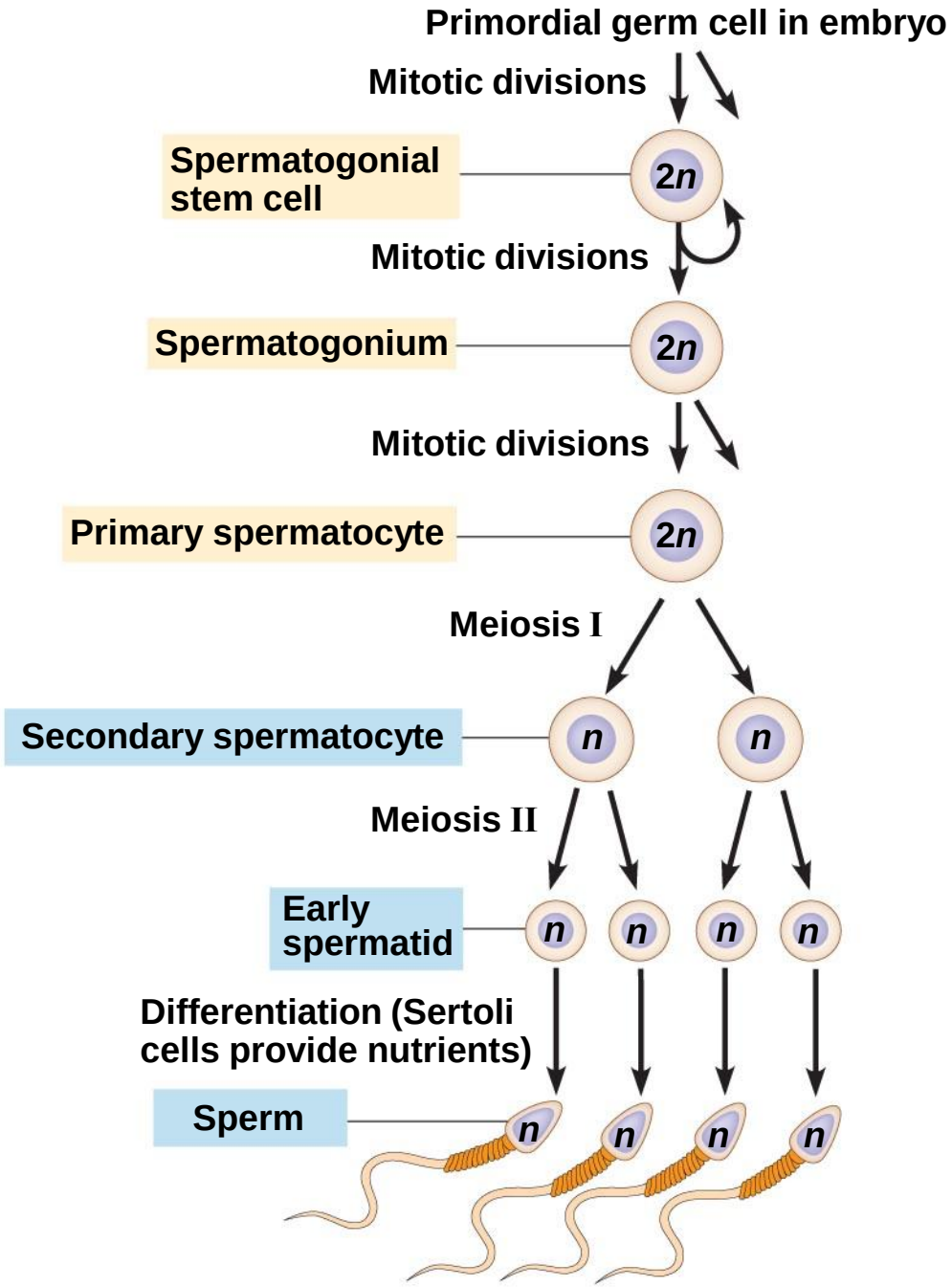


Fig. 46-12f

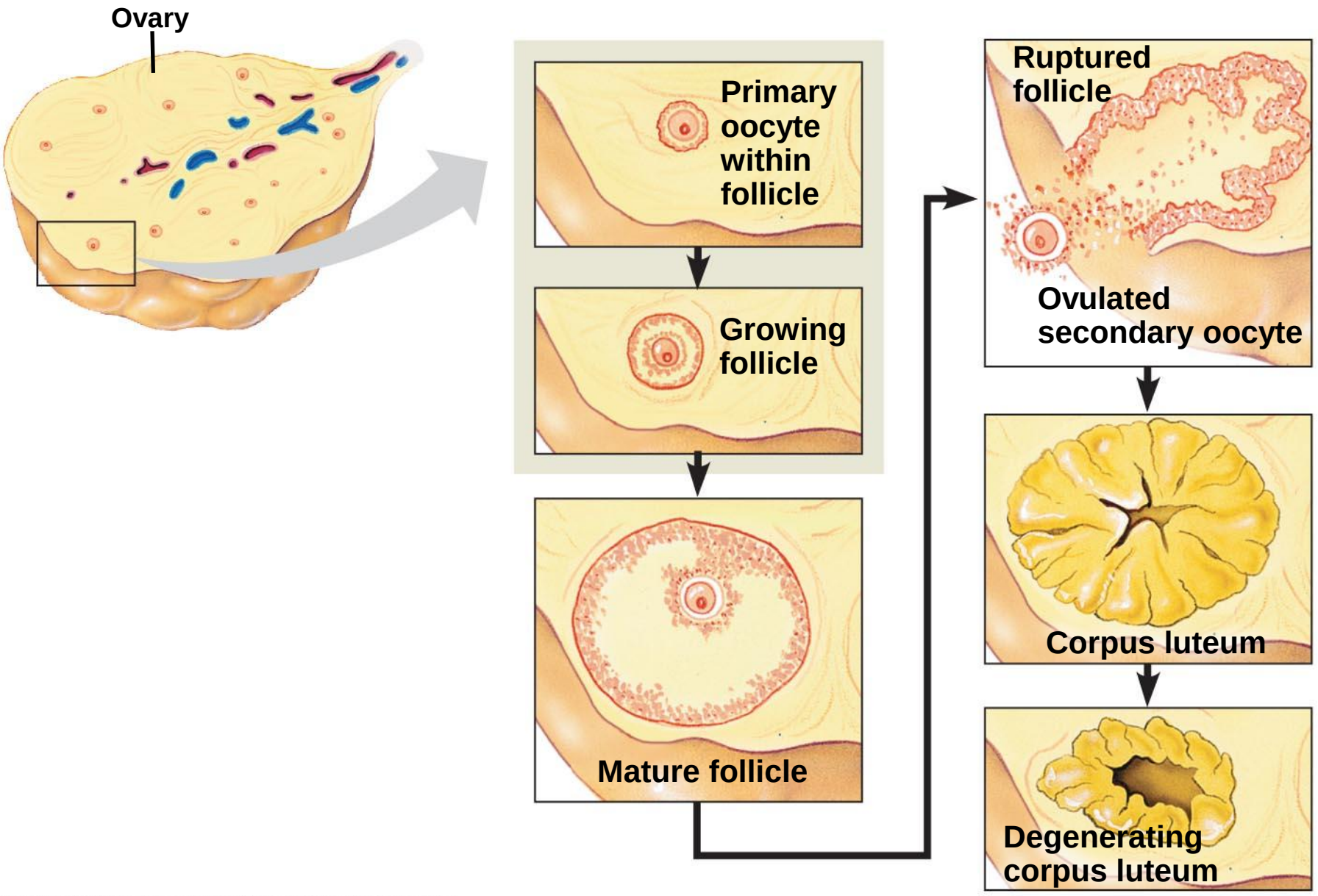
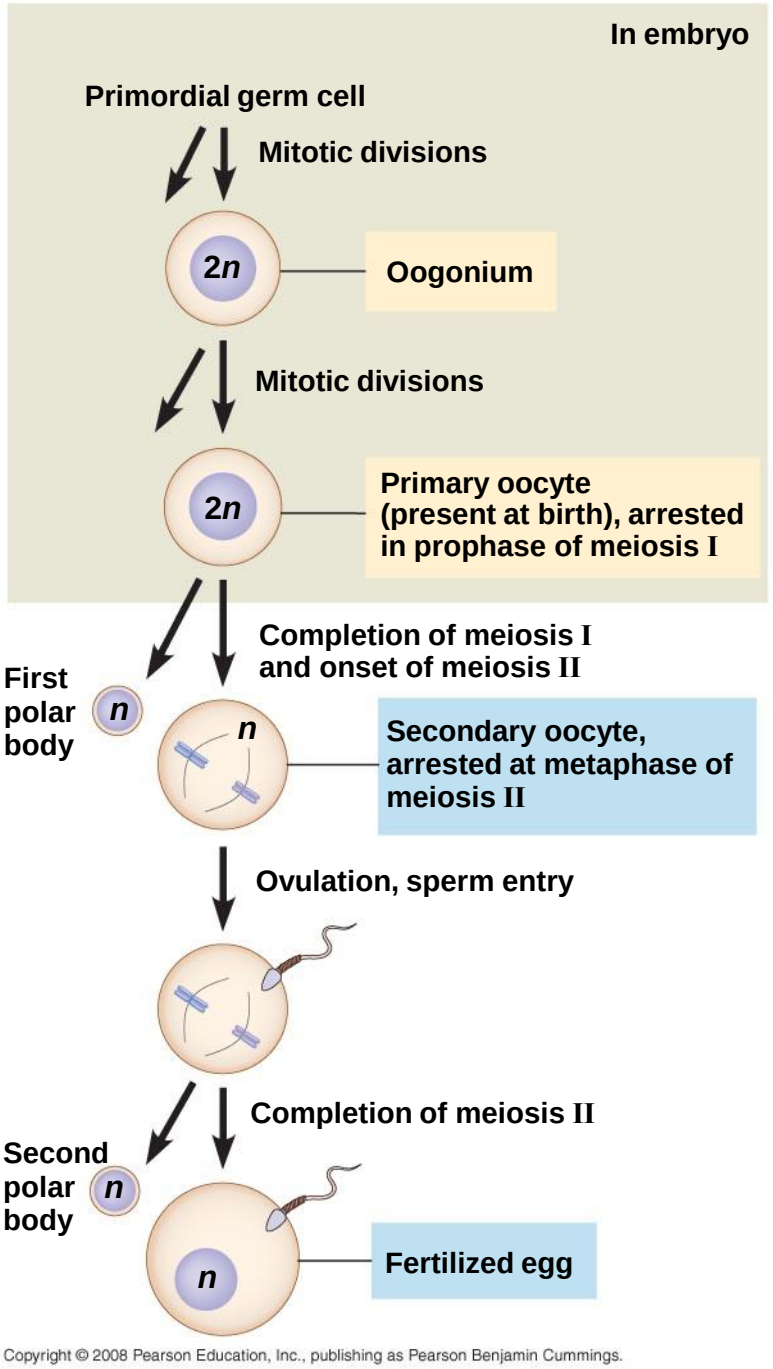
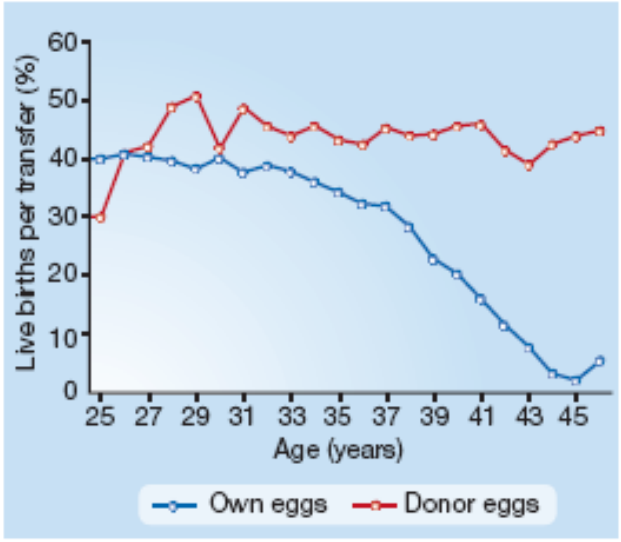


Fig. 46-12g



- Spermatogenesis differs from oogenesis:
  - In oogenesis, one egg forms from each cycle of meiosis; in spermatogenesis four sperm form from each cycle of meiosis
  - Oogenesis ceases later in life in females; spermatogenesis continues throughout the adult life of males
  - Oogenesis has long interruptions; spermatogenesis produces sperm from precursor cells in a continuous sequence



Germline stem cells and follicular renewal in the postnatal mammalian ovary

Joshua Johnson*, Jacqueline Canning*, Tomoko Kaneko, James K. Pru & Jonathan L. Tilly

Vincent Center for Reproductive Biology, Vincent Obstetrics and Gynecology Service, Massachusetts General Hospital, and Department of Obstetrics, Gynecology and Reproductive Biology, Harvard Medical School, Boston, Massachusetts 02114, USA

*These authors contributed equally to this work

Fig. 46-13

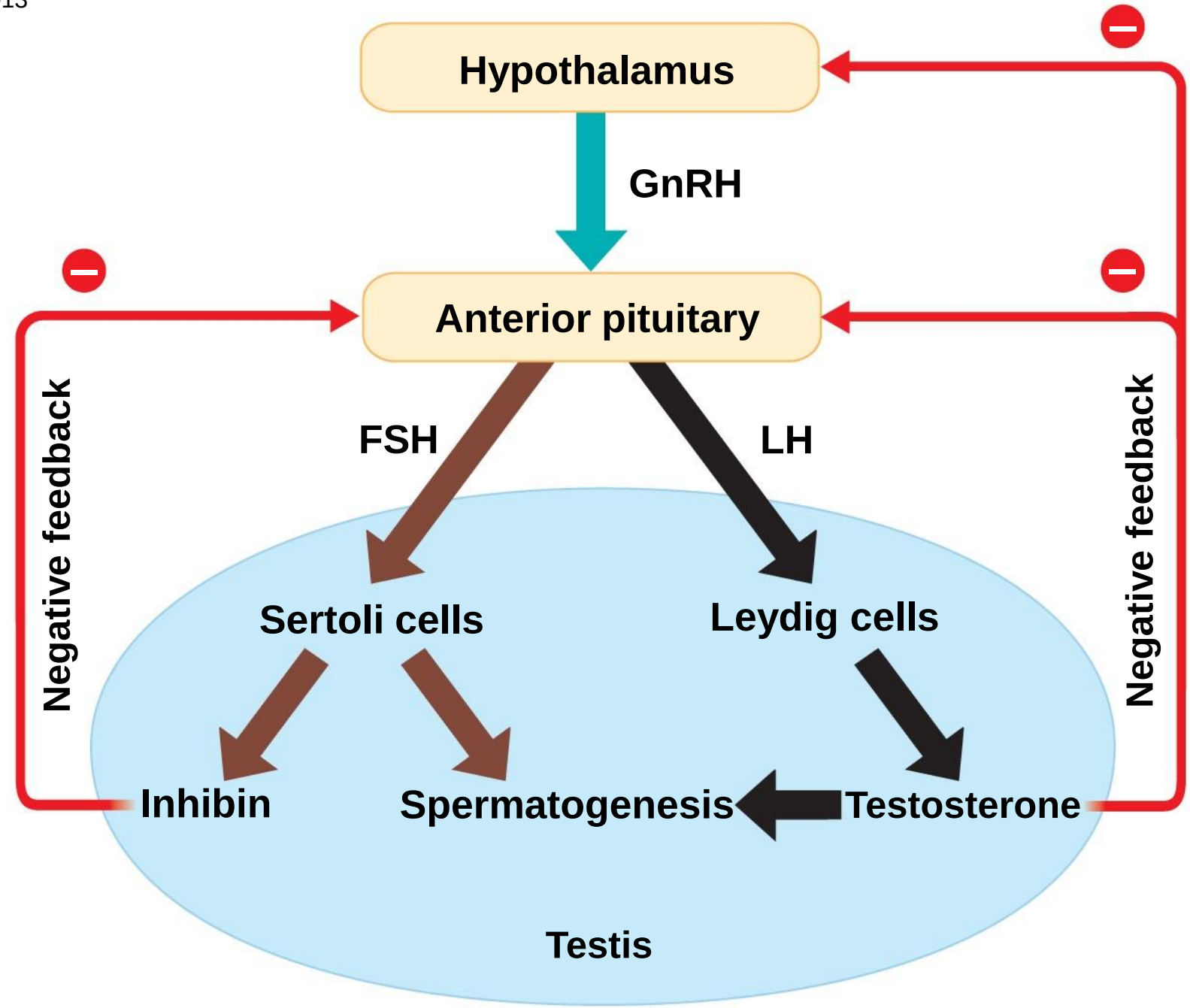
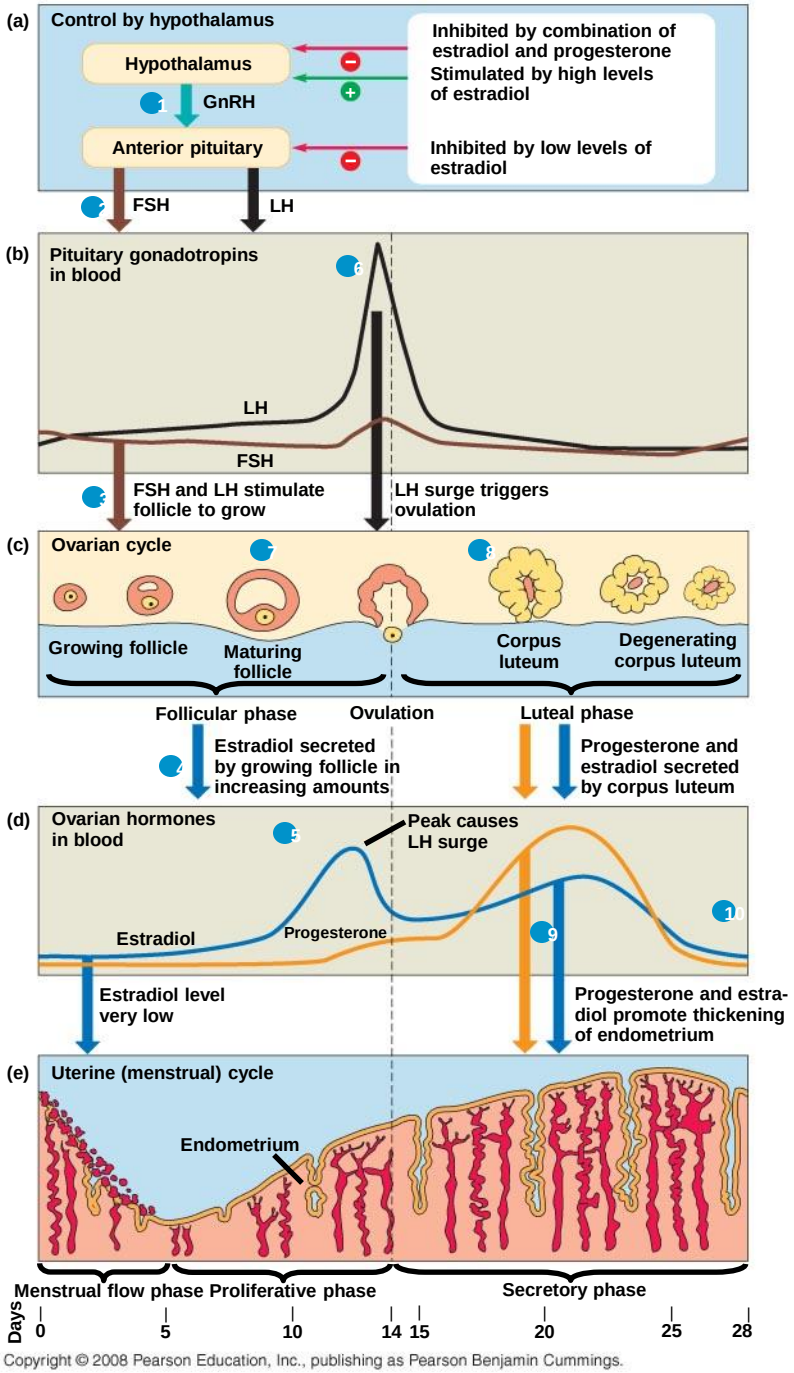


Fig. 46-14



- Cells of the uterine lining can sometimes migrate to an abnormal, or **ectopic**, location
- Swelling of these cells in response to hormone stimulation results in a disorder called **endometriosis**

Menopause

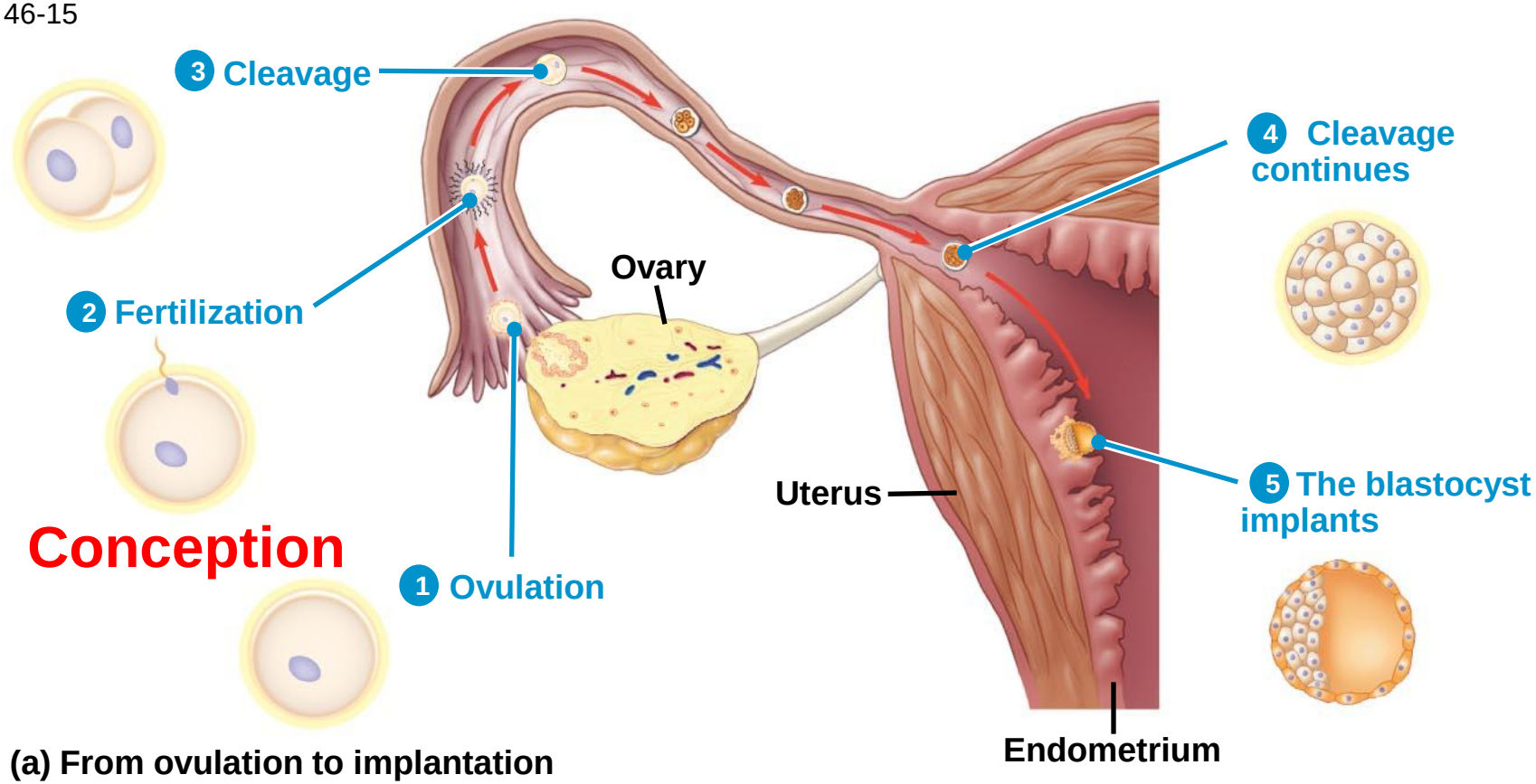
- After about 500 cycles, human females undergo **menopause**, the cessation of ovulation and menstruation
- Menopause is very unusual among animals
- Menopause might have evolved to allow a mother to provide better care for her children and grandchildren

Menstrual Versus Estrous Cycles

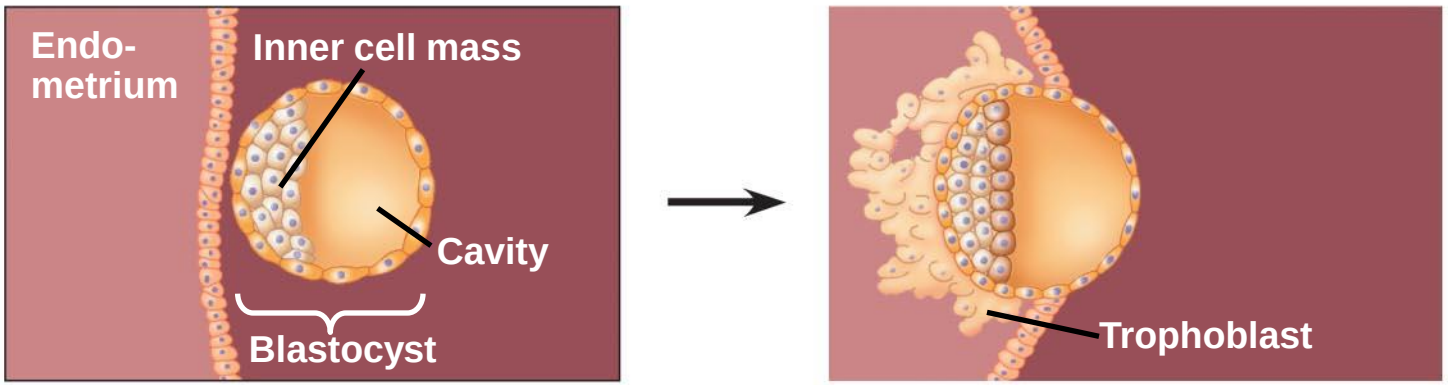
- Menstrual cycles are characteristic of humans and some other primates:
  - The endometrium is shed from the uterus in a bleeding called menstruation
  - Sexual receptivity is not limited to a timeframe

- **Estrous cycles** are characteristic of most mammals:
  - The endometrium is reabsorbed by the uterus
  - Sexual receptivity is limited to a “heat” period
  - The length and frequency of estrus cycles varies from species to species

Fig. 46-15



(a) From ovulation to implantation

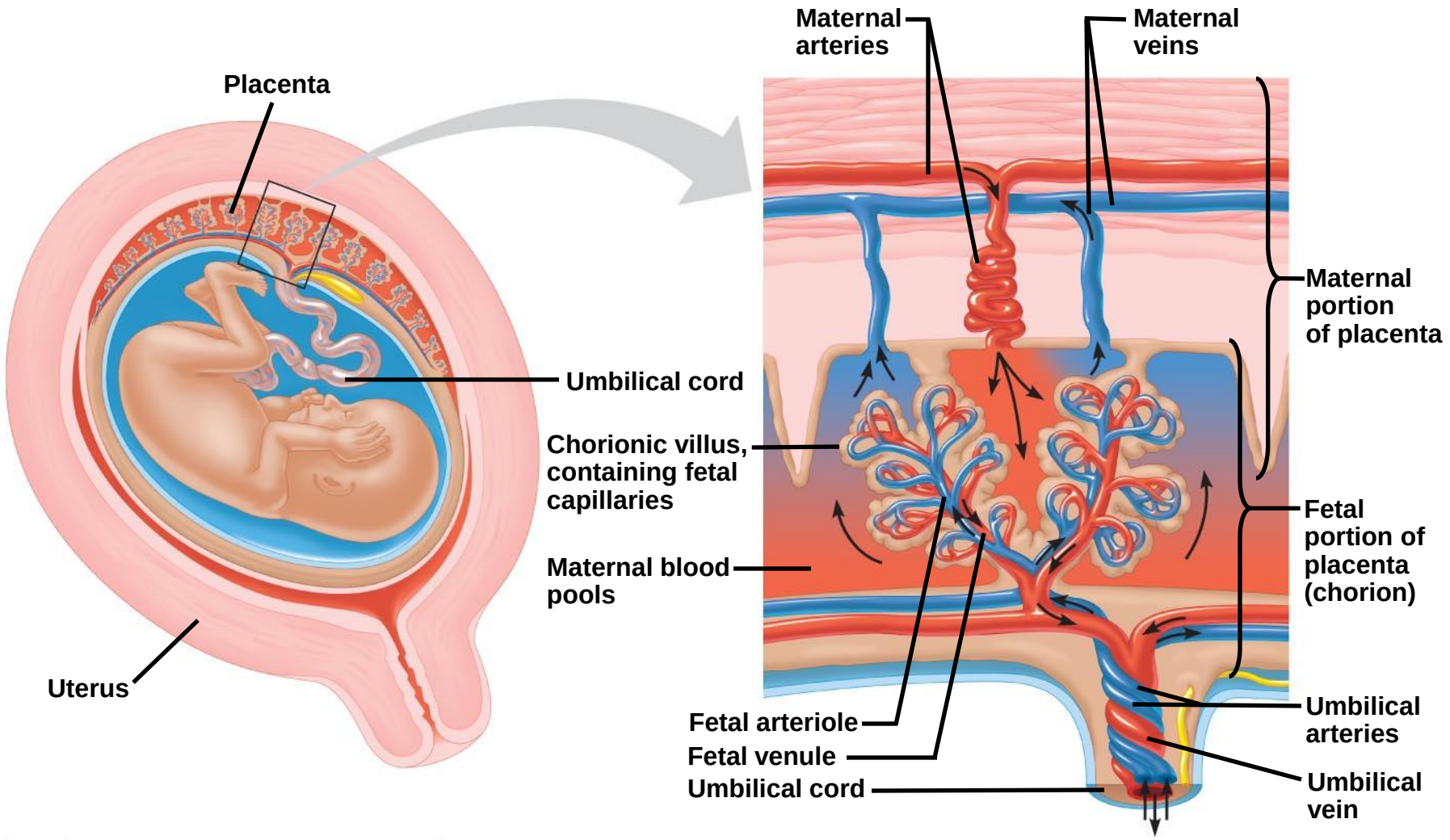


(b) Implantation of blastocyst

- The embryo releases **human chorionic gonadotropin (hCG),** which prevents menstruation

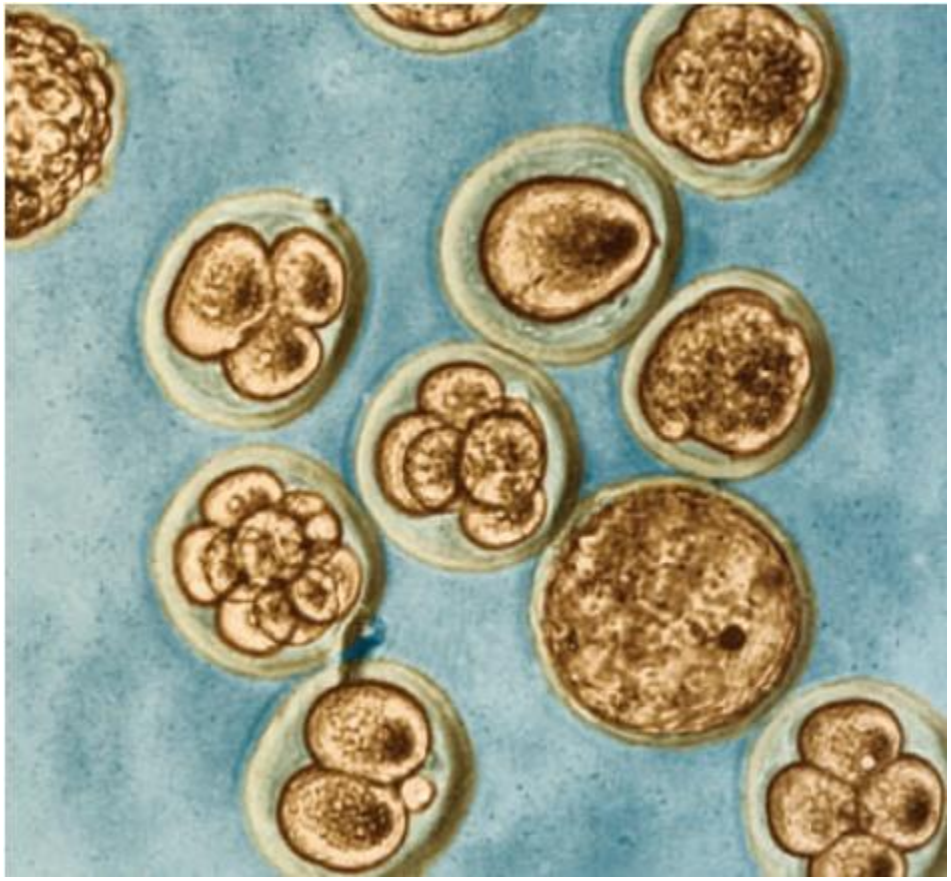
Fig. 46-16

Placental circulation



- Splitting of the embryo during the first month of development results in genetically identical twins
- Release and fertilization of two eggs results in fraternal and genetically distinct twins

Human embryos can split and become twins early or late in development



Nine-banded armadillos consistently give birth to genetically identical quadruplets

- The first trimester is the main period of **organogenesis**, development of the body organs
- All the major structures are present by 8 weeks, and the embryo is called a **fetus**

- Changes occur in the mother
  - Growth of the placenta
  - Cessation of ovulation and the menstrual cycle
  - Breast enlargement
  - Nausea is also very common

Fig. 46-17

Human fetal development

(a) 5 weeks

(b) 14 weeks

(c) 20 weeks

Fig. 46-18

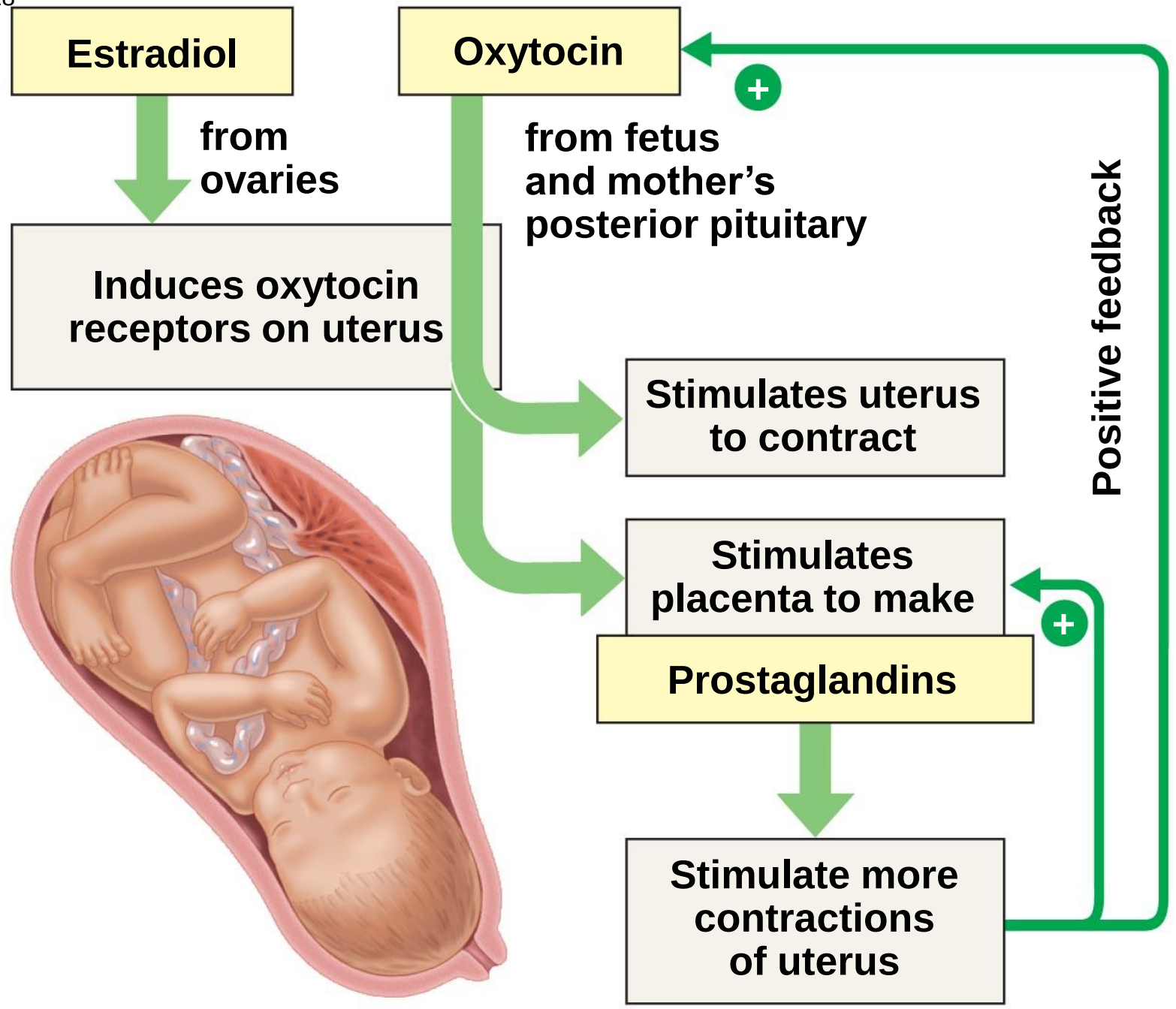
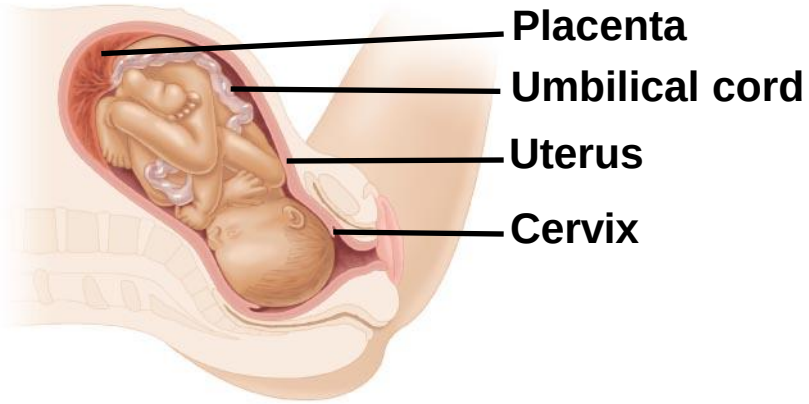
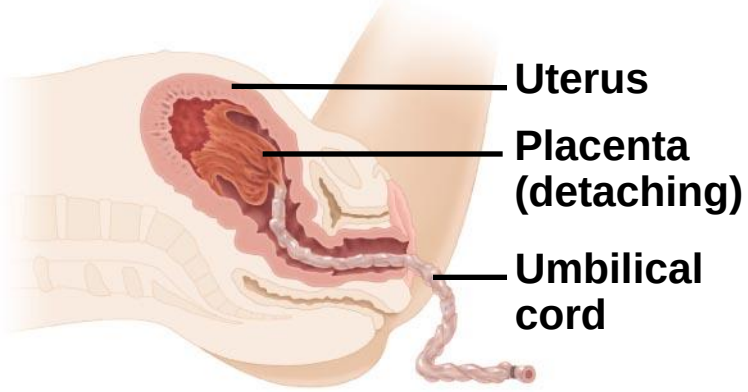


Fig. 46-19-4



1 Dilation of the cervix

2 Expulsion: delivery of the infant



3 Delivery of the placenta

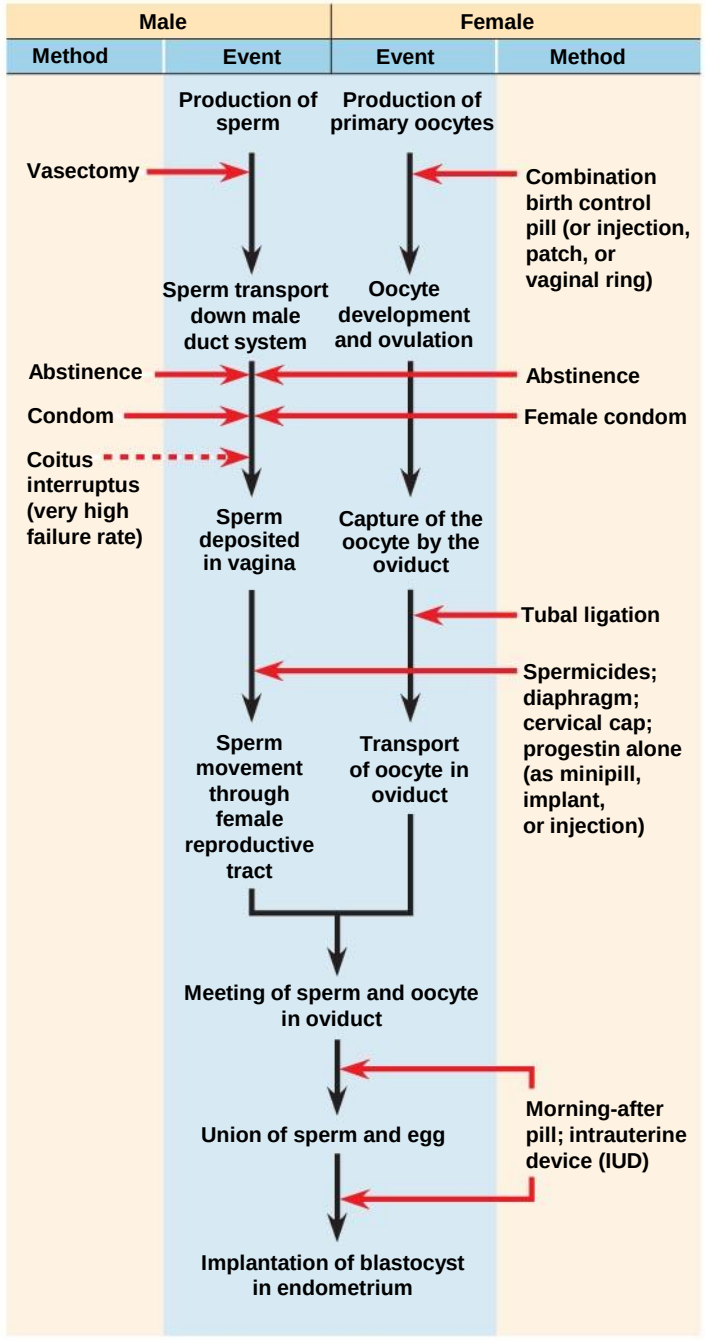
Maternal Immune Tolerance of the Embryo and Fetus

- A woman's acceptance of her "foreign" offspring is not fully understood
- It may be due to suppression of the immune response in her uterus

Contraception and Abortion

- **Contraception**, the deliberate prevention of pregnancy, can be achieved in a number of ways
- Contraceptive methods fall into three categories:
  - Preventing release of eggs and sperm
  - Keeping sperm and egg apart
  - Preventing implantation of an embryo

Fig. 46-20



- **Abortion** is the termination of a pregnancy
- Spontaneous abortion, or miscarriage, occurs in up to one-third of all pregnancies
- The drug RU486 results in an abortion within the first 7 weeks of a pregnancy

Detecting Disorders During Pregnancy

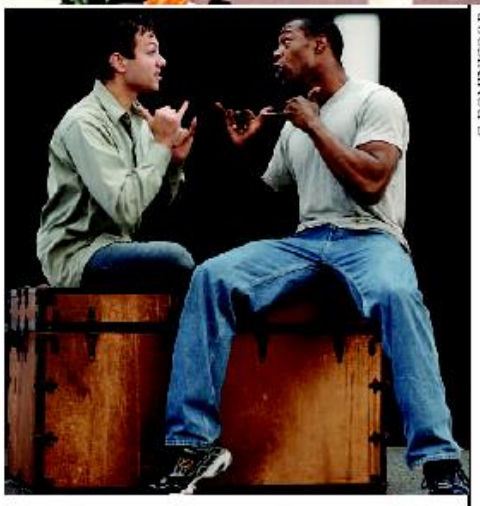
- Amniocentesis and chorionic villus sampling are invasive techniques in which amniotic fluid or fetal cells are obtained for genetic analysis
- Noninvasive procedures usually use ultrasound imaging to detect fetal condition
- Genetic testing of the fetus poses ethical questions and can present parents with difficult decisions

NATURE | VOL 431 | 21 OCTOBER 2004 | www.nature.com/nature

DEAF by design

Employing genetic diagnosis to avoid having a baby with a disability is controversial enough. But a minority of deaf people would consider testing to ensure that they had a deaf child. Carina Dennis finds out why.

S. PERLMAN/AP



G. DOMENICO/AP

All together now: deaf culture now encompasses everything from spelling bees (audience shown applauding, above) to Broadway shows (right).

John and Karen — not their real names — are both deaf, and desperately wanted a deaf baby. But genetic testing showed that this was extremely unlikely. "They were devastated," recalls Arti Pandya, a clinical geneticist at Virginia Commonwealth University in Richmond, who counselled the couple. It was two years before they got over their disappointment and started trying to conceive their first child.

The couple's attitude will shock many people. If you can hear, it's hard to understand why anyone would want a deaf child. But John and Karen's views are not that unusual among those who identify themselves as 'Deaf' with a capital 'D'. The Deaf view their condition not as a disability, but the experience," says Gary Kerridge, regional disability liaison officer at the University of Ballarat in Mount Helen, Australia, who lost his hearing as a young child.

For deaf children, the majority of whom are born to hearing parents, even family gatherings can be lonely affairs. Many of them feel liberated by their first experience of Deaf culture. "They learn to sign and suddenly for the first time, after years of being isolated and struggling, they are accepted," says Kerridge. "Naturally, they quickly develop a strong attachment to the Deaf way of life."

Treating Infertility

- Modern technology can provide infertile couples with **assisted reproductive technologies**
- ***In vitro* fertilization (IVF)** mixes eggs with sperm in culture dishes and returns the embryo to the uterus at the 8 cell stage
- Sperm are injected directly into an egg in a type of IVF called **intracytoplasmic sperm injection (ICSI)**

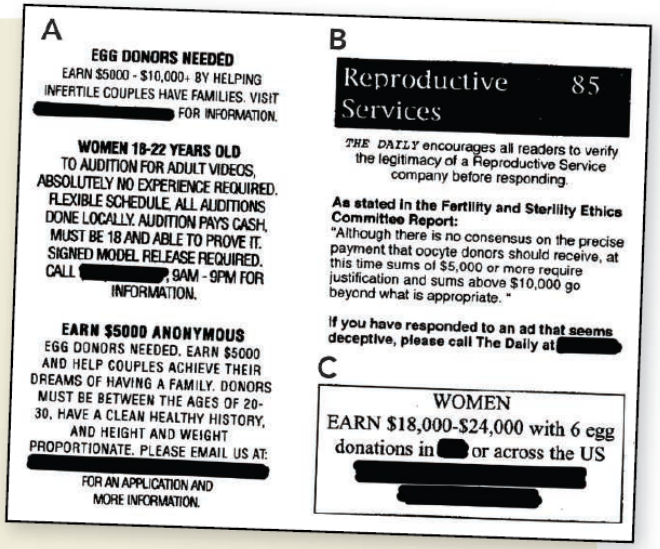
fertility

D. LUBIA/TAXI/GETTY

Age is no barrier…

Advances in reproductive medicine hint that female fertility might be extended into late middle age and beyond. But will the methods be safe? And is society ready for this demographic shift? Kendall Powell investigates.

The Price of Eggs


A

EGG DONORS NEEDED
EARN $5000 - $10,000+ BY HELPING INFERTILE COUPLES HAVE FAMILIES. VISIT [redacted] FOR INFORMATION.

WOMEN 18-22 YEARS OLD
TO AUDITION FOR ADULT VIDEOS, ABSOLUTELY NO EXPERIENCE REQUIRED. FLEXIBLE SCHEDULE. ALL AUDITIONS DONE LOCALLY. AUDITION PAYS CASH. MUST BE 18 AND ABLE TO PROVE IT. SIGNED MODEL RELEASE REQUIRED. CALL [redacted], 9AM - 9PM FOR INFORMATION.

EARN $5000 ANONYMOUS
EGG DONORS NEEDED. EARN $5000 AND HELP COUPLES ACHIEVE THEIR DREAMS OF HAVING A FAMILY. DONORS MUST BE BETWEEN THE AGES OF 20-30, HAVE A CLEAN HEALTHY HISTORY, AND HEIGHT AND WEIGHT PROPORTIONATE. PLEASE EMAIL US AT: [redacted]
FOR AN APPLICATION AND MORE INFORMATION.

B

Reproductive Services 85

THE DAILY encourages all readers to verify the legitimacy of a Reproductive Service company before responding.

As stated in the Fertility and Sterility Ethics Committee Report:
"Although there is no consensus on the precise payment that oocyte donors should receive, at this time sums of $5,000 or more require justification and sums above $10,000 go beyond what is appropriate."

If you have responded to an ad that seems deceptive, please call The Daily at [redacted]

C

WOMEN
EARN $18,000-$24,000 with 6 egg donations in [redacted] or across the US
[redacted]

While bioethicists continue to agonize over whether women should be compensated for donating oocytes to research, the U.S. market for eggs for assisted reproduction is flourishing. According to an article in the spring issue of the *Hastings Center Report*, some donors are offered tens of thousands of dollars, and the likelihood of having a high SAT score may be more important than appearance or ethnicity in determining the value of a student's oocytes.

Aaron D. Levine, assistant professor of public policy at the Georgia Institute of Technology in Atlanta, obtained copies of student newspapers from 366 colleges and universities around the country. He found 111 ads soliciting egg donors in 65 different student newspapers, in what he believes is the "first national cross-sectional sample" of such ads. He found that top fees were offered at the institutions with the highest average SAT scores of incoming students, and he calculated that every increase of 100 SAT points increased the bounty by $1930. That amount roughly doubled if the advertisements were placed on behalf of a specific couple. One ad, which ran in *The Harvard Crimson*, *The Daily Princetonian*, and *Yale Daily News,* offered $35,000 to an attractive athletic donor with an SAT score over 1400.

Levine says he doesn't think the situation has changed much since 2006 when most of the data were collected: He recently spoke at Duke University, where he saw two ads, for $10,000 and $15,000 each. At nearby but lower-SAT-scoring University of North Carolina, oocytes were sought for only $2500.

ABC WORLD NEWS WITH DIANE SAWYER

Cheaper Overseas: Surrogate Mothers In-Vitro Fertilization Is $6,000 in India, and $60, 000 in the U.S.

HYDERBAD, India, April 27, 2010

You should now be able to:

1. Distinguish between asexual and sexual reproduction
2. Explain how hermaphroditism may be advantageous to animals that have difficulty encountering a member of the opposite sex
3. Describe various ways in which animals may protect developing embryos
4. Using diagrams, identify and state the function of each component of the male and female reproductive systems

5. Describe oogenesis and spermatogenesis; describe three major differences between them

6. Explain how the uterine and ovarian cycles are synchronized and describe the functions of the hormones involved

7. List the various methods of contraception, how each works, and how effective each is

8. Describe techniques that allow us to learn about the health and genetics of a fetus