Chapter 11

Reproduction and Embryonic Development

ASEXUAL AND SEXUAL REPRODUCTION

Asexual reproduction results in the generation of genetically identical offspring

- **Asexual reproduction**
  - One parent produces genetically identical offspring
  - Very rapid reproduction
  - Can proceed via
    - Budding
    - Fission
    - Fragmentation/ regeneration


Copyright © 2009 Pearson Education, Inc.

Asexual reproduction of an aggregating Sea anemone (*Anthopleura elegantissima*) by fission

Sexual reproduction results in the generation of genetically unique offspring

- Some animals exhibit hermaphroditism
  - One individual with male and female reproductive systems
  - Easier to find a mate for animals less mobile or solitary

Hermaphroditic earthworms mating


Copyright © 2009 Pearson Education, Inc.

Sexual reproduction results in the generation of genetically unique offspring

- Sperm may be transferred to the female by
  - External fertilization
    - Many fish and amphibian species
    - Eggs and sperm are discharged near each other
  - Internal fertilization
    - Some fish and amphibian species
    - Nearly all terrestrial animals
    - Sperm is deposited in or near the female reproductive tract


Copyright © 2009 Pearson Education, Inc.

Frogs in an embrace that triggers the release of eggs and sperm

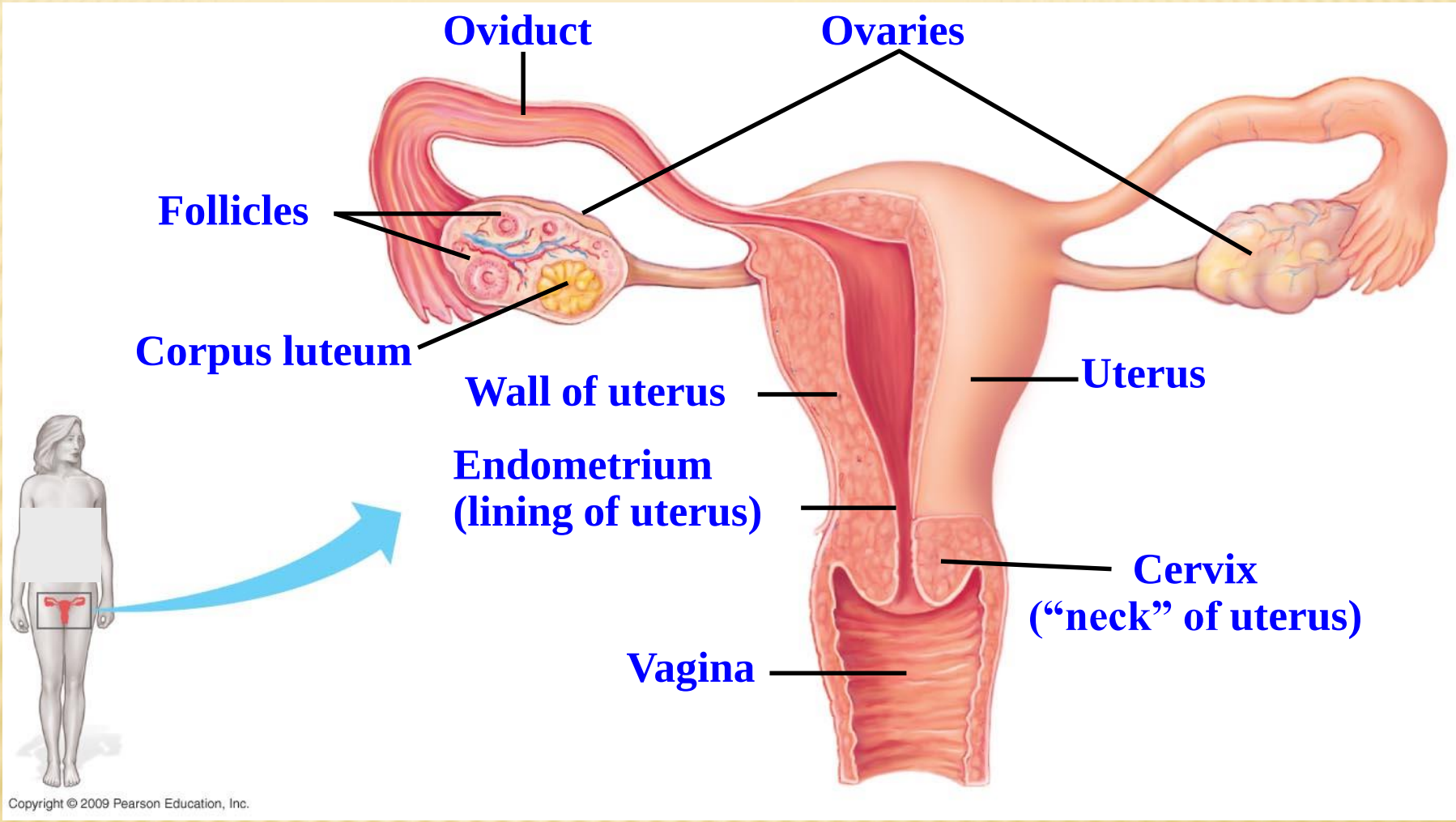
Human Reproduction

Reproductive anatomy of the human female

- **Both sexes in humans have**
  - **A set of gonads where gametes (sperms & ova) are produced**
  - **Ducts for gamete transport**
  - **Structures for copulation**

Human Female Reproductive anatomy

- Ovaries contain follicles that Nurture eggs and Produce sex hormones
- Oviducts convey eggs to the uterus where embryos develop
- The uterus opens into the vagina through the cervix
- The vagina
  - Receives the penis during sexual intercourse
  - Forms the birth canal



Copyright © 2009 Pearson Education, Inc.

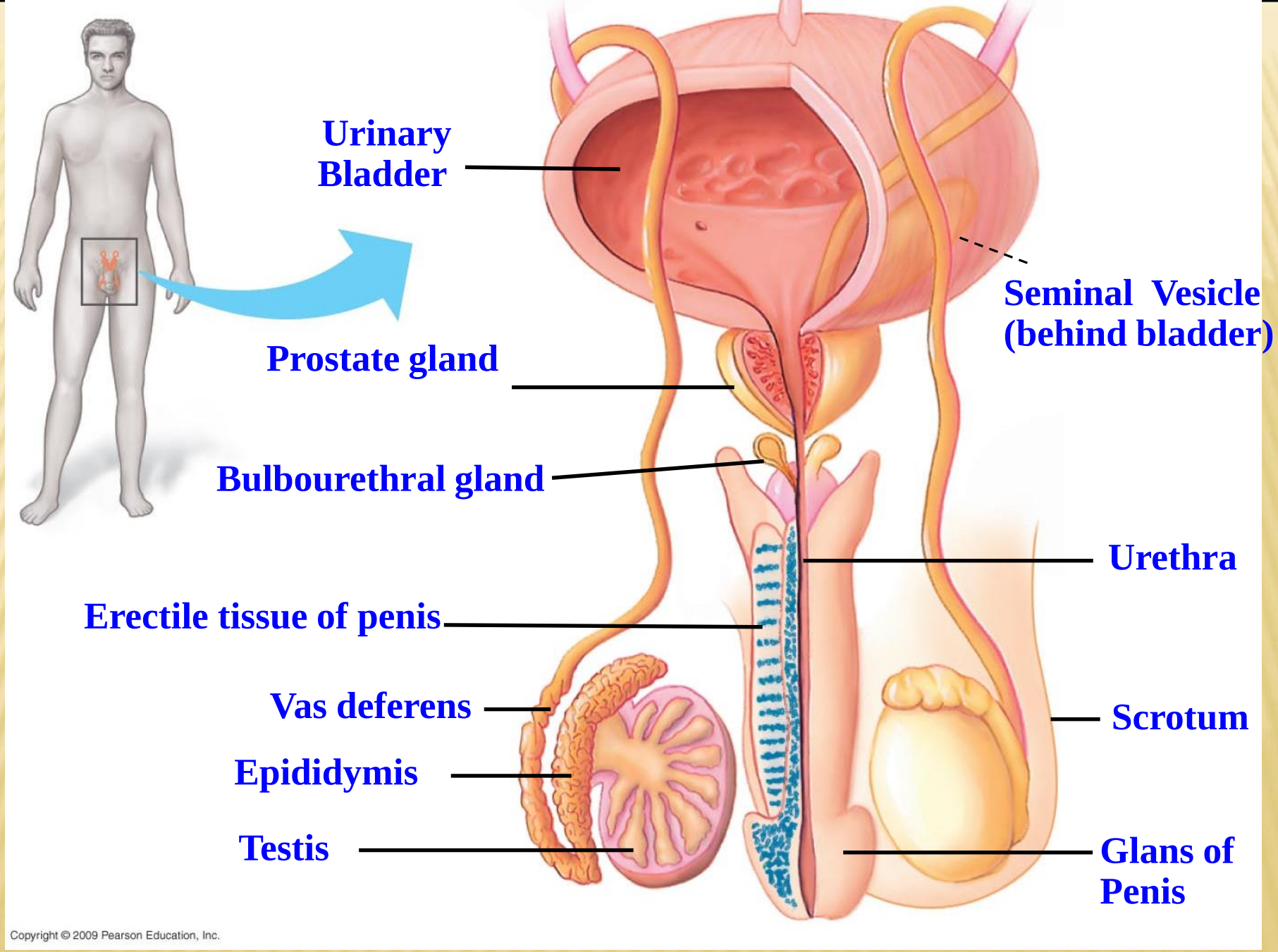
Front view of female reproductive anatomy (upper portion)

Human Male Reproductive anatomy

- Testes (singular *testis*) produce Sperm and male hormones
- Epididymis stores sperm as they develop further
- Several glands contribute to semen
  - Seminal vesicles
  - Prostate
  - Bulbourethral

Sperm production (Spermatogenesis)

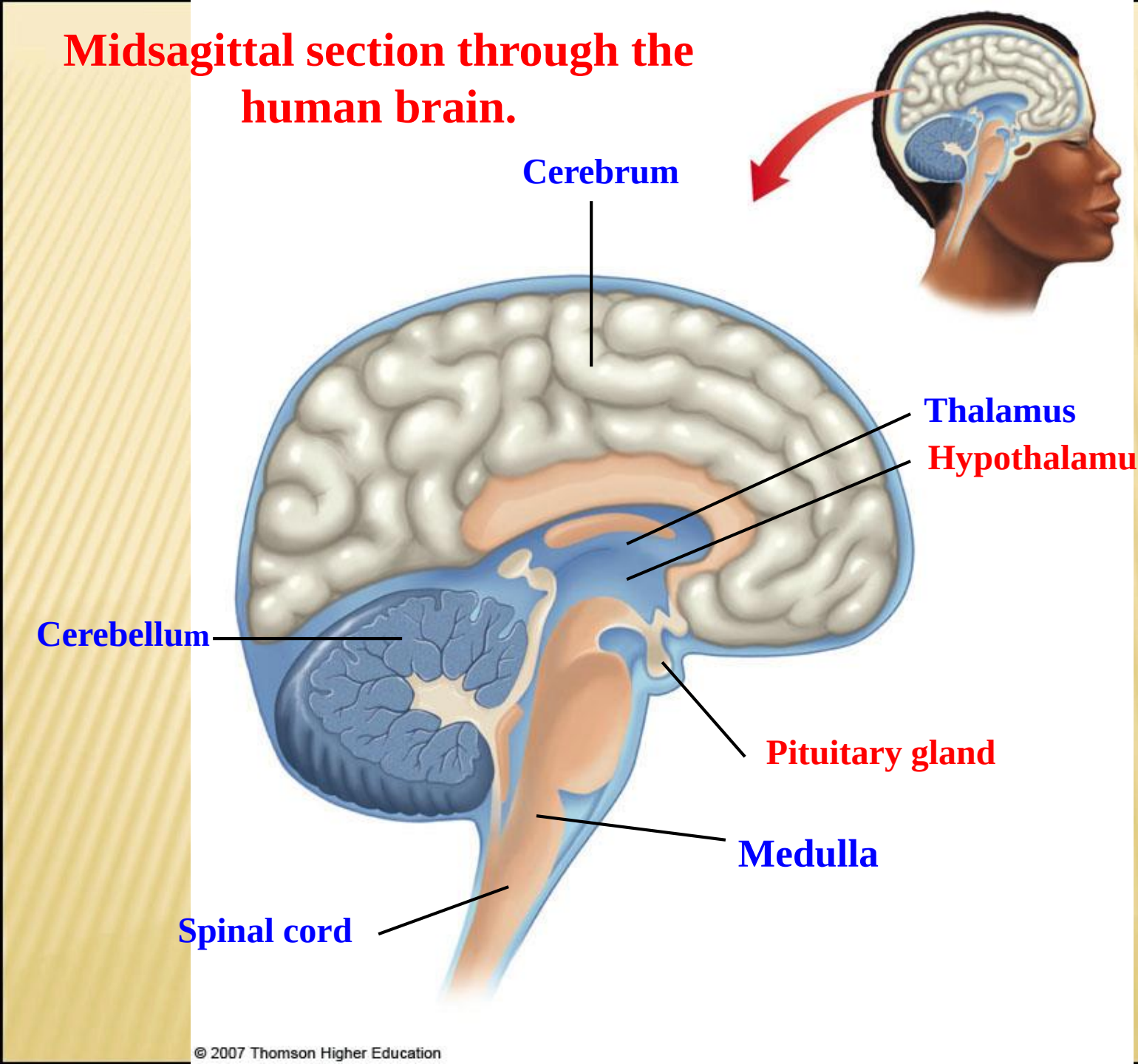
- Regulated by a negative feedback system of hormones
- Involves the hypothalamus, pituitary, and testes



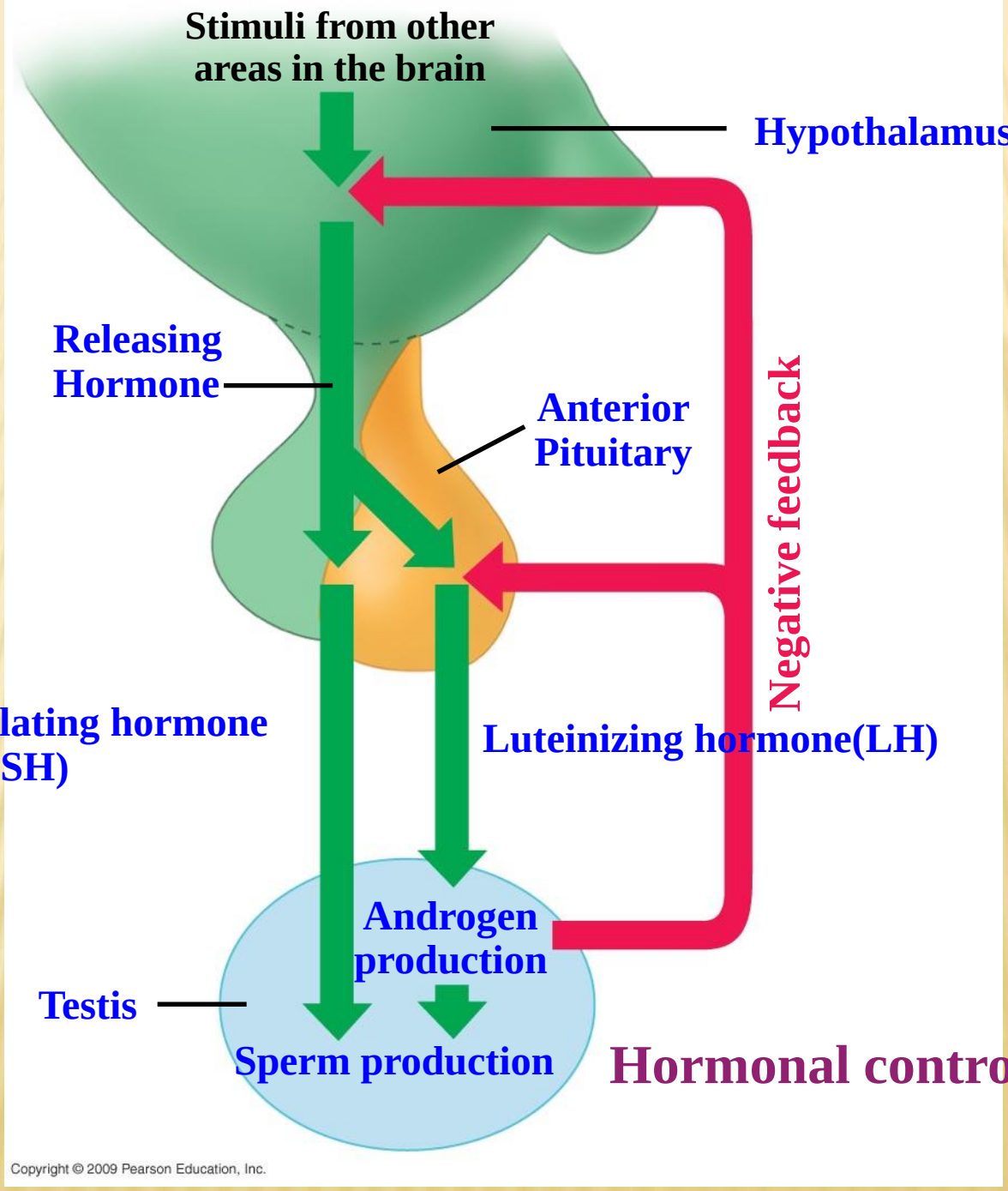
Copyright © 2009 Pearson Education, Inc.

Front view of male reproductive anatomy

Midsagittal section through the human brain.



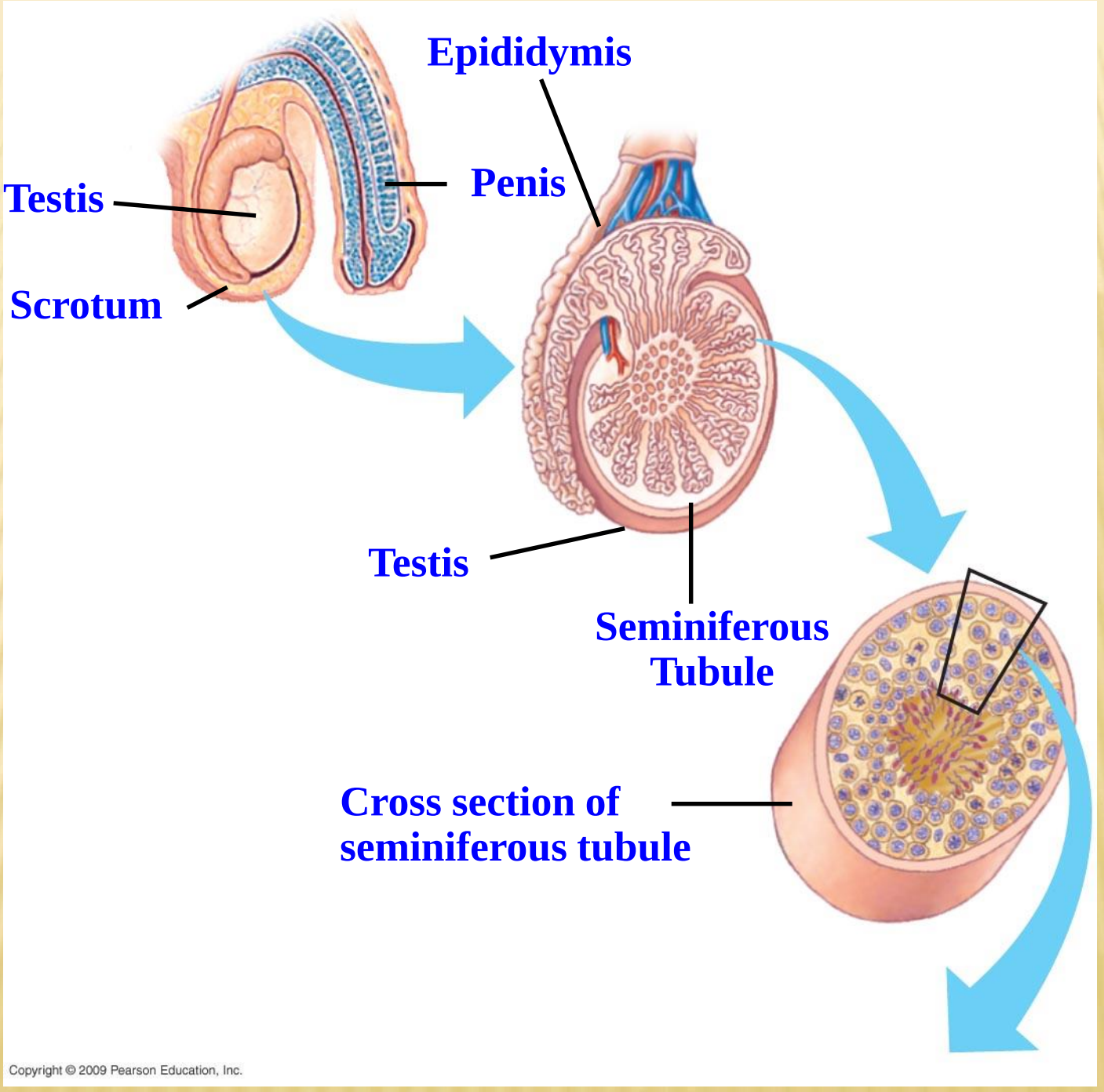
© 2007 Thomson Higher Education



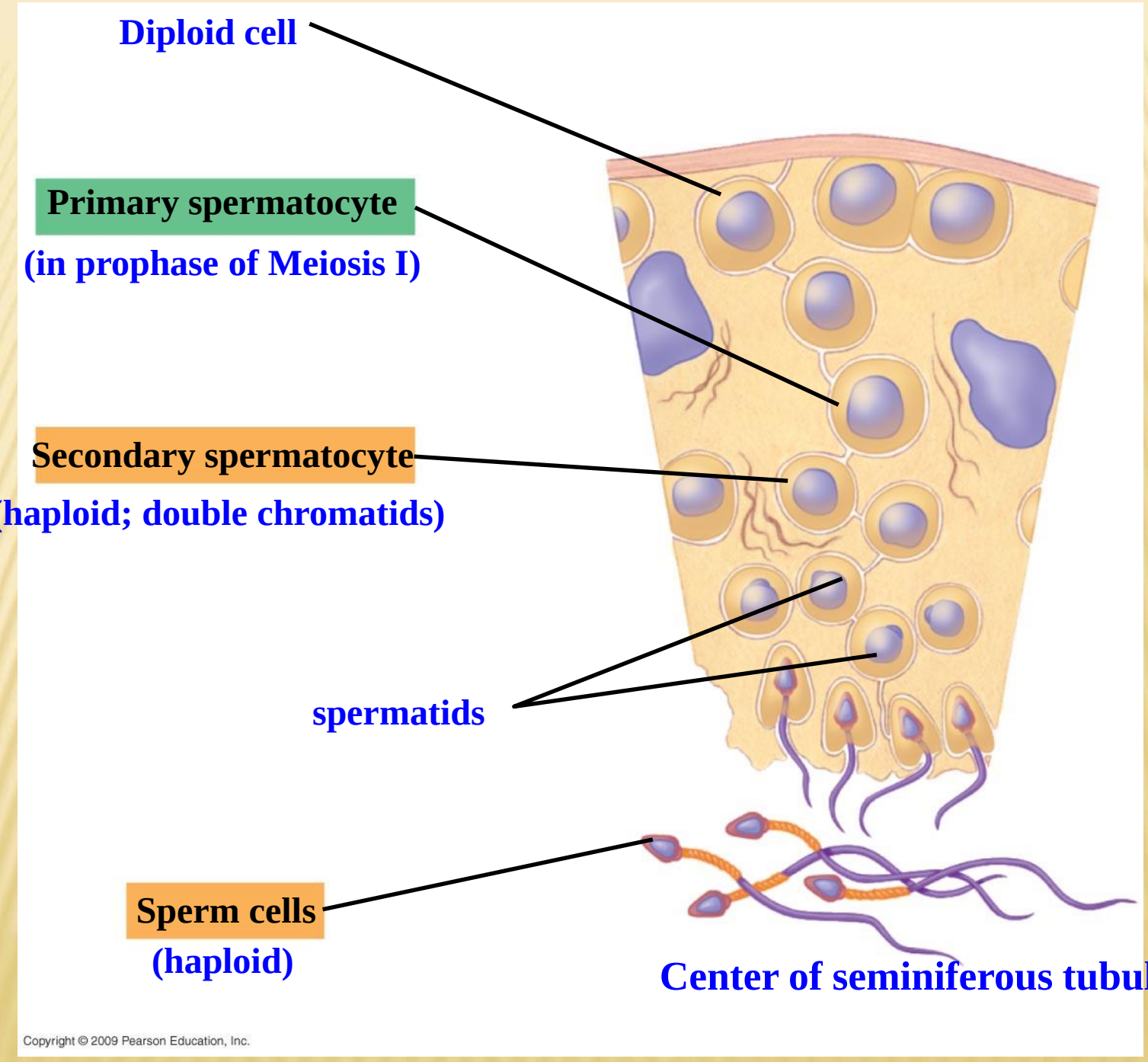
Hormonal control of the testis

Spermatogenesis (The formation of sperm)

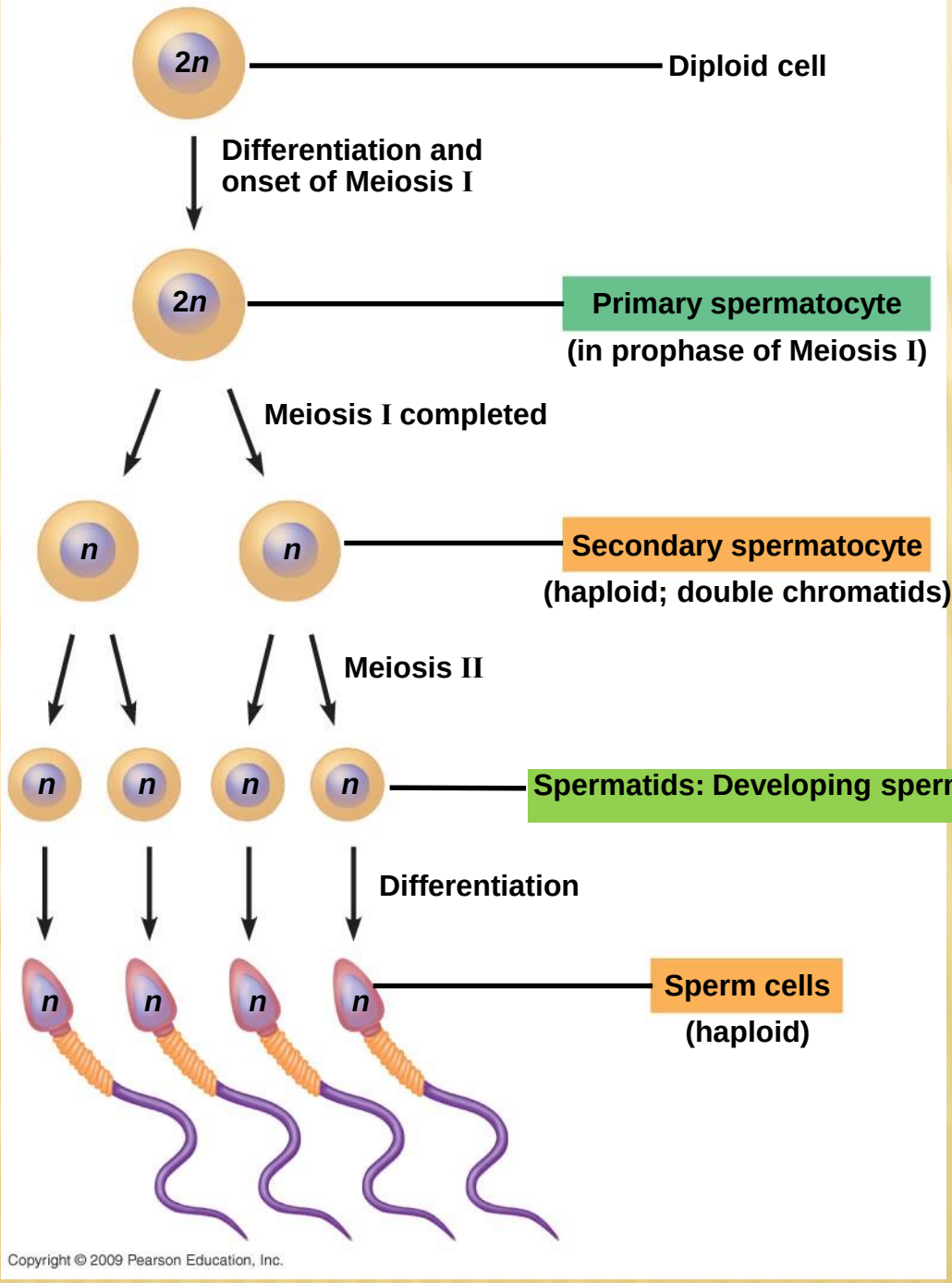
- **Spermatogenesis**
  - **Occurs in seminiferous tubules**
  - **Primary spermatocytes**
    - **Formed by mitosis**
    - **Divide by meiosis I to produce secondary spermatocytes**
  - **Secondary spermatocytes divide by meiosis II to produce spermatids**
  - **Round spermatids differentiate into elongate sperm**
  - **Mature sperm released into seminiferous tubule and stored in the epididymis**



Copyright © 2009 Pearson Education, Inc.

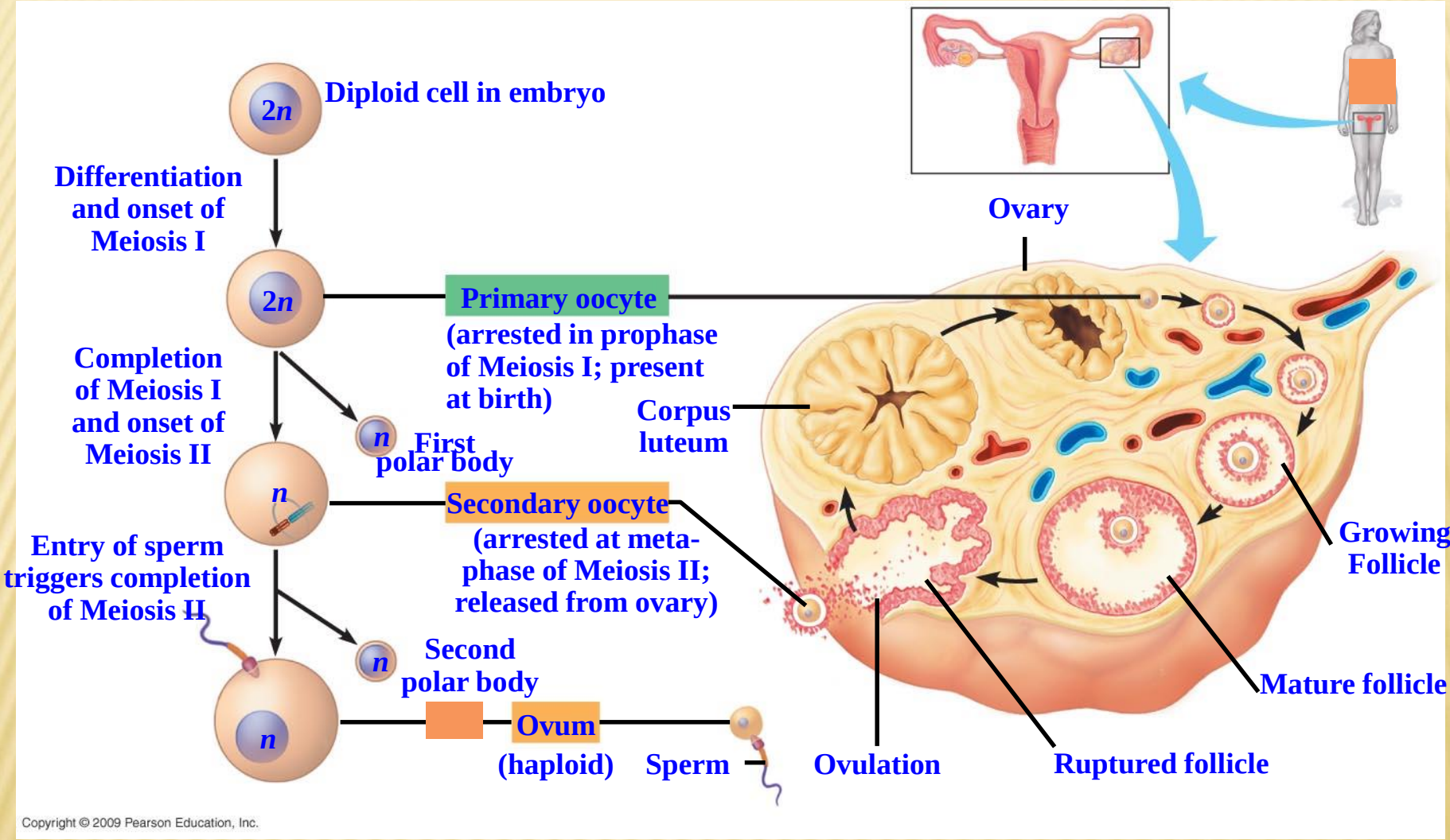


Copyright © 2009 Pearson Education, Inc.


2n
Diploid cell
Differentiation and onset of Meiosis I
2n
Primary spermatocyte
(in prophase of Meiosis I)
Meiosis I completed
n
n
Secondary spermatocyte
(haploid; double chromatids)
Meiosis II
n
n
n
n
Spermatids: Developing sperm cells
Differentiation
n
n
n
n
Sperm cells
(haploid)
Copyright © 2009 Pearson Education, Inc.

Oogenesis (The formation of egg)

- **Oogenesis**
  - **Begins before birth: diploid cells start meiosis and stop**
  - **Each month about one primary oocyte resumes meiosis**
  - **A secondary oocyte arrested at metaphase of meiosis II is ovulated**
  - **Meiosis of the ovum is completed after fertilization**



Oogenesis and the development of an ovarian follicle

Hormones synchronize cyclic changes in the ovary and uterus

- **Ovarian and menstrual cycles**

Occur about every 28 days

Hypothalamus signals the anterior pituitary to secrete follicle-stimulating hormone (FSH) and leuteinizing hormone (LH), which trigger

- **Growth of a follicle**
- **Ovulation**

Hormones synchronize cyclic changes in the ovary and uterus

- **After ovulation, empty ovarian follicle becomes corpus luteum**
- **Corpus luteum secretes estrogen and progesterone hormones, which**

1) **Stimulate the endometrium to thicken**
2) **Prepare the uterus for implantation of the embryo**
3) **Inhibit hypothalamus, reducing FSH and LH secretion**

Hormones synchronize cyclic changes in the ovary and uterus

- **If egg is fertilized**
  - **Embryo releases hormones that maintain the uterine lining**
  - **Menstruation does not occur**
- **If egg is not fertilized**
  - **Drop in LH shuts down corpus luteum and its hormones**
  - **Menstruation is triggered**
  - **Hypothalamus and pituitary stimulate development of a new follicle**

Embryonic Development

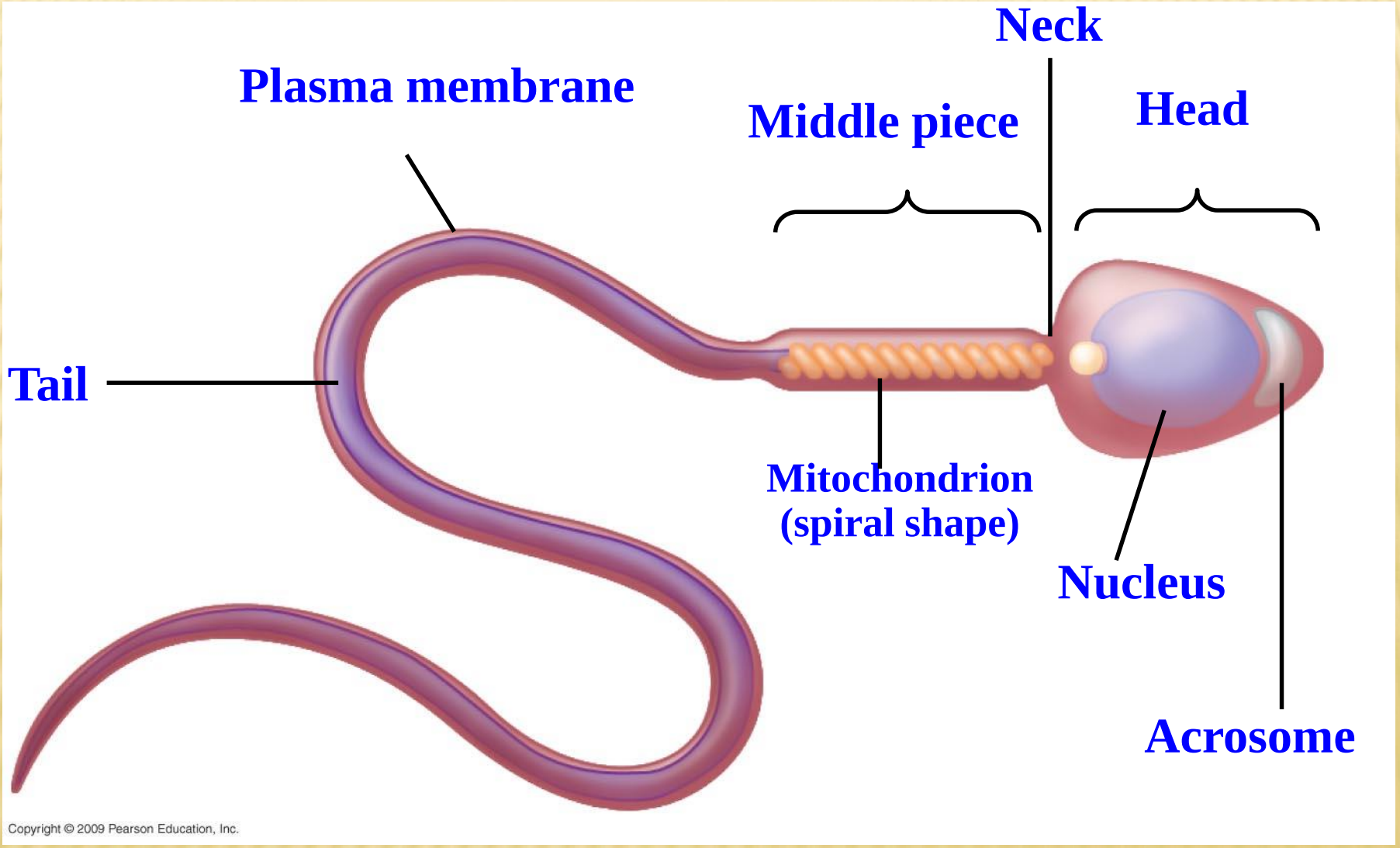
- Embryonic development begins with fertilization
- Fertilization is the union of sperm and egg to form a diploid zygote
- Resulted zygote triggers embryonic development

Fertilization

Sperm adaptation

Sperm are adapted to reach and fertilize an egg

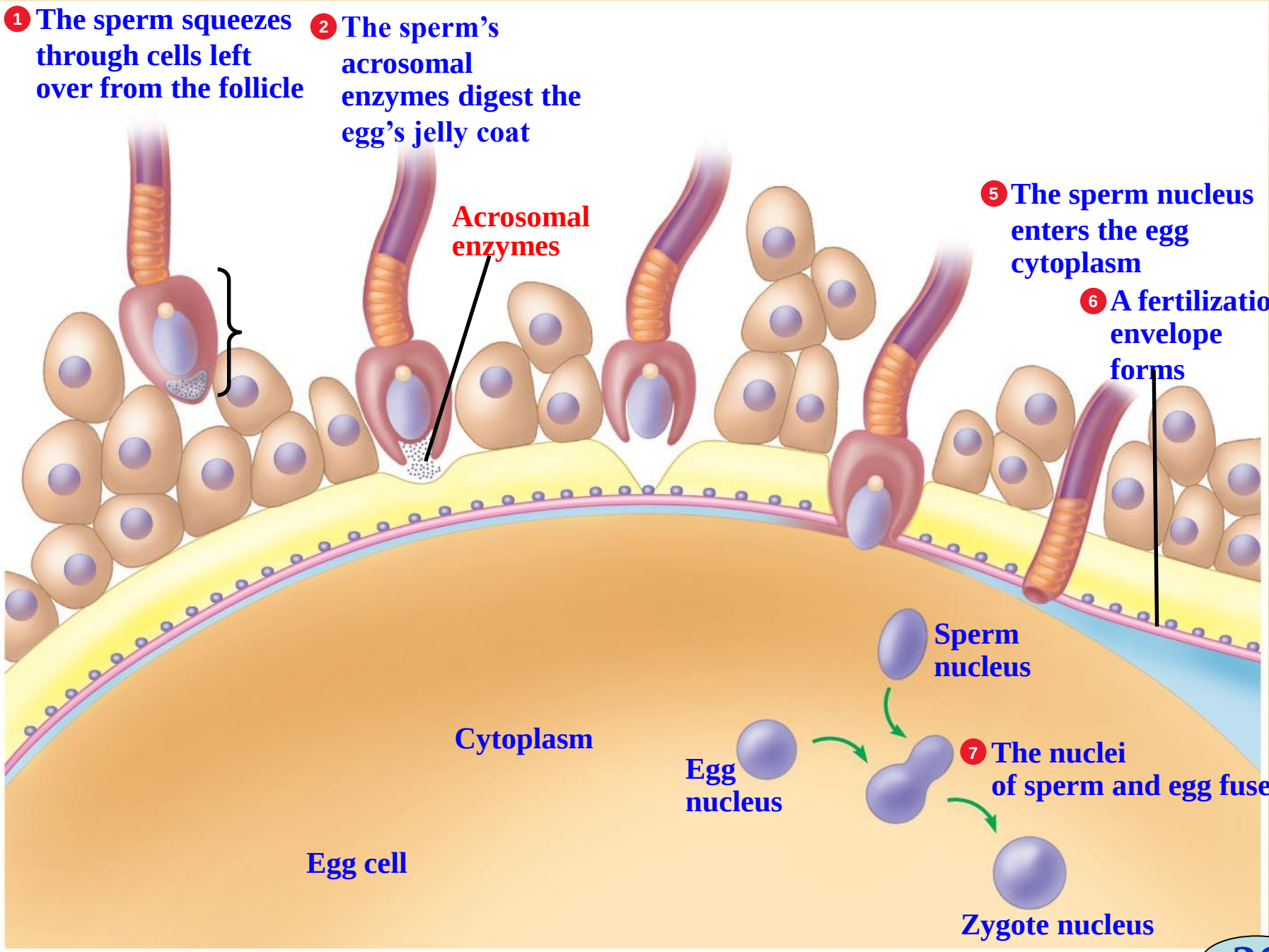
- **Streamlined shape moves more easily through fluids**
- **Many mitochondria provide ATP for tail movements**
- **Head contains a haploid nucleus Tipped with an acrosome containing penetrating enzymes**



The structure of a human sperm cell

Fertilization results in a zygote and triggers embryonic development

- **Fertilization events**
  - Sperm squeeze past follicle cells
  - Acrosomal enzymes pierce egg's coat
  - Sperm binds to vitelline layer
  - Sperm and egg plasma membranes fuse
  - Egg is stimulated to develop further
  - Egg and sperm nuclei fuse

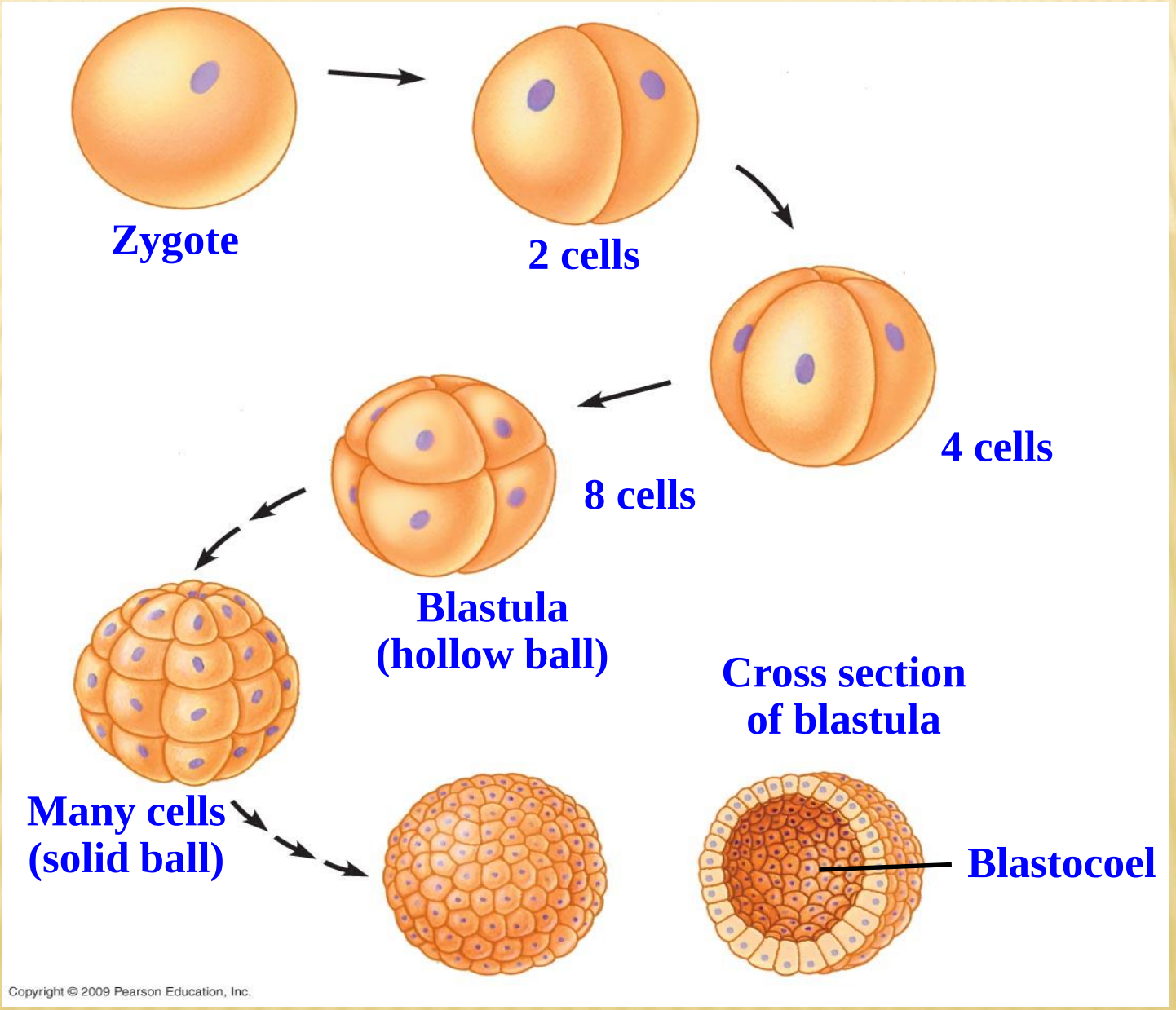


Copyright © 2009 Pearson Education, Inc.

Embryonic development
1. Cleavage

- Cleavage is a rapid series of cell divisions
- Cleavage produces a ball of cells from the zygote
  - More cells
  - Embryo does not get larger
  - Thus new cells are smaller in size
  - A ball of cells called blastula is formed at the end of cleavege

Cleavage

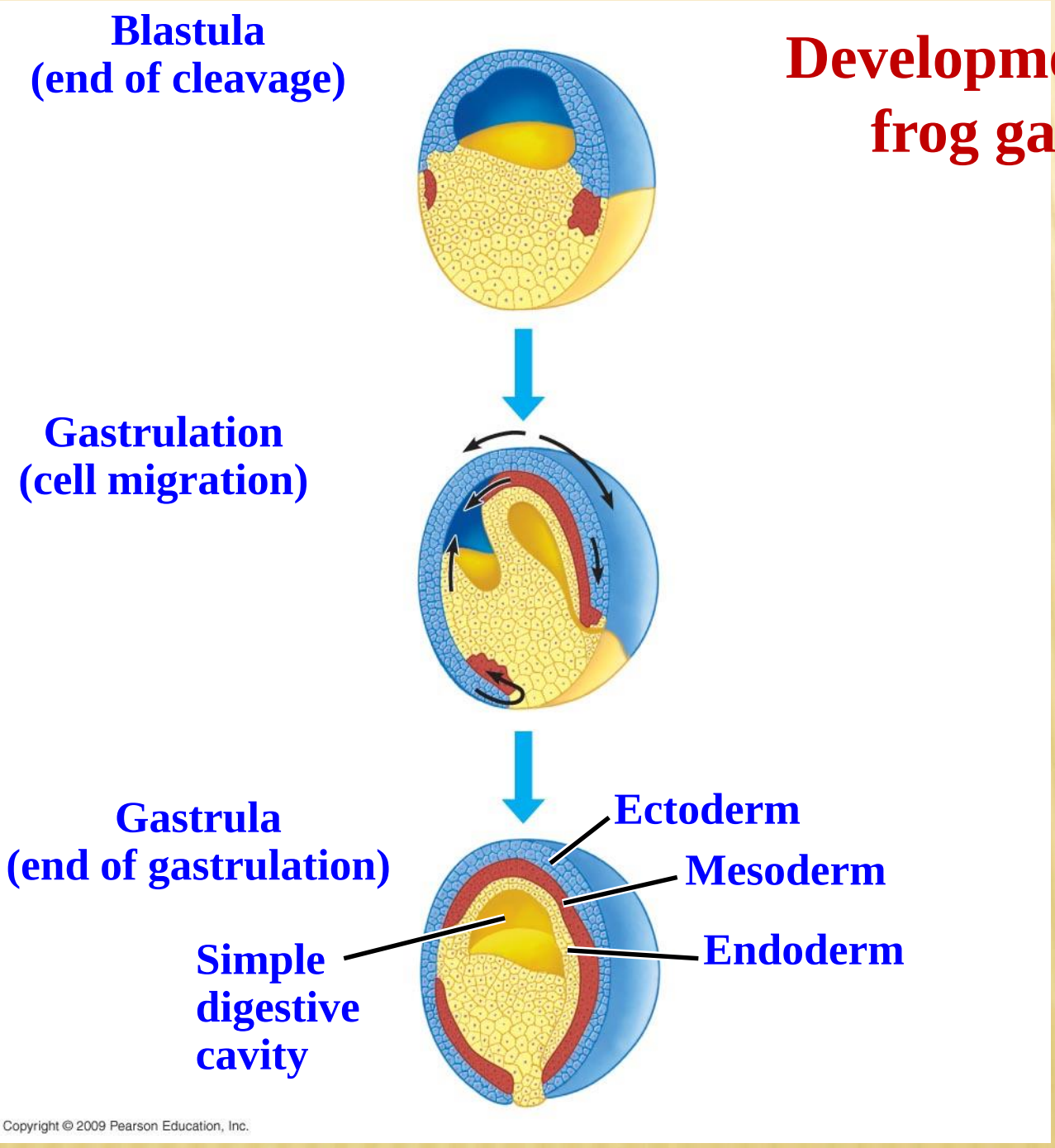

Zygote
2 cells
4 cells
8 cells
Blastula
(hollow ball)
Cross section
of blastula
Many cells
(solid ball)
Blastocoel
Copyright © 2009 Pearson Education, Inc.

2. Gastrulation produces a three-layered embryo

- Gastrulation
- The blastula (ball of similar cells) resulted from cleavage go to gastrulation
  - Cells migrate
  - The basic body plan of three layers is established
    - Ectoderm outside - becomes skin and nervous systems
    - Endoderm inside - becomes digestive tract
    - Mesoderm in middle - becomes muscle and bone

Copyright © 2009 Pearson Education, Inc.

Development of the frog gastrula



Copyright © 2009 Pearson Education, Inc.