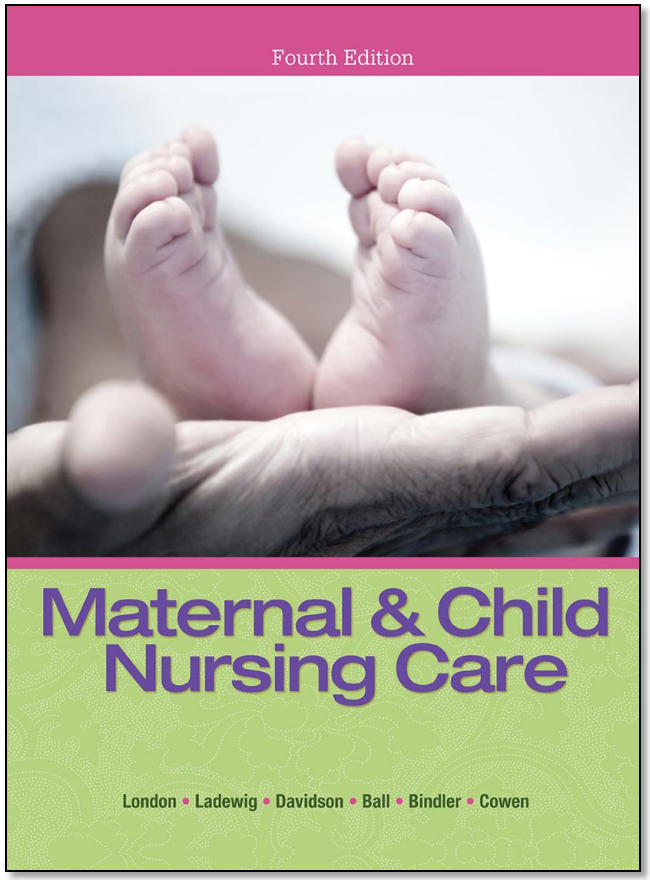
MATERNAL & CHILD NURSING CARE

FOURTH EDITION



CHAPTER 4

Conception and Fetal Development

Mitosis vs Meiosis

Mitosis:

- For growth & repair
- Division: 1
- Parent cell: 2nucli, diploid
- Daughter cell: 2 2n identical to parent cell
- Somatic cells

Meiosis

- For reproduction
- Division: 2
- Parent cell: 2n diploid
- Daughter cells: 4 1n not identical to parent cell called gametes, germ cells, sex cells
- Reproductive cells

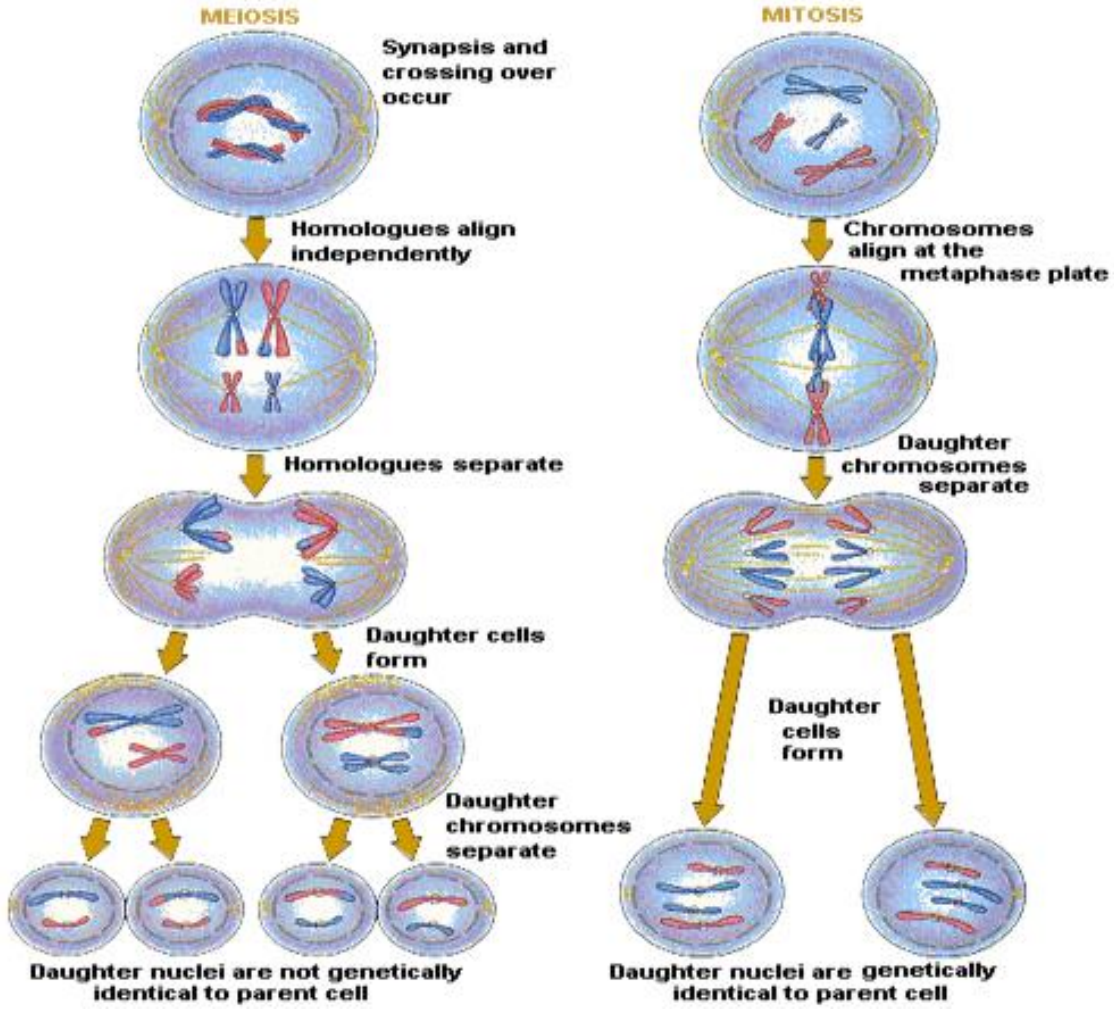

MEIOSIS
Synapsis and crossing over occur
Homologues align independently
Homologues separate
Daughter cells form
Daughter chromosomes separate
Daughter nuclei are not genetically identical to parent cell
MITOSIS
Chromosomes align at the metaphase plate
Daughter chromosomes separate
Daughter cells form
Daughter nuclei are genetically identical to parent cell

Table 4–1 Comparison of Meiosis and Mitosis

Process	Purpose	Cell Division	Number of Daughter Cells
Meiosis	Produce reproductive cells (gametes). Reduction of chromosome number by half (from diploid [46] to haploid [23]), so that when fertilization occurs the normal diploid number is restored. Introduces genetic variability.	Two-stage reduction.	Four daughter cells, each containing one half the number of chromosomes as the mother cell, or 23 chromosomes. Nonidentical to original cell.
Mitosis	Produce cells for growth and tissue repair. Cell division characteristic of all somatic cells.	One-stage cell division.	Two daughter cells identical to the mother cell, each with the diploid number (46 chromosomes).

Learning Outcome 4-2

Compare the processes by which ova and sperm are produced.

Oogenesis

- Process that produces the female gamete, called an ovum (egg), that begins to develop early in the fetal life of the female
  - Ovaries begin to develop early in the fetal life of the female
  - All ova that female will produce in her lifetime are present at birth
    - Ovary gives rise to oogonial cells, which develop into oocytes البويضات

Oogenesis

- Oogenesis
  - During puberty
    - Mature primary oocyte continues through first meiotic division in ovary
  - Haploid cells released at ovulation

Spermatogenesis

- Production of the male gamete, or sperm, during puberty

Spermatogenesis

- During the first meiotic division
  - Spermatogonium forms two cells called secondary spermatocytes
  - Each contains 22 double-structured autosomal chromosomes and either double-structured X sex chromosome or double-structured Y sex chromosome

Menstrual cycle [HOMEWORK: self learning]

- If egg doesn't implant within few days, endometrium will begin to decay & menstruation will occur within 2 weeks

- If oocyte fertilized by sperm, it will implant in thickened endometrium

Learning Outcome 4-3

Describe the components of the process of fertilization as to how each may impact fertilization.

Preparation for Fertilization

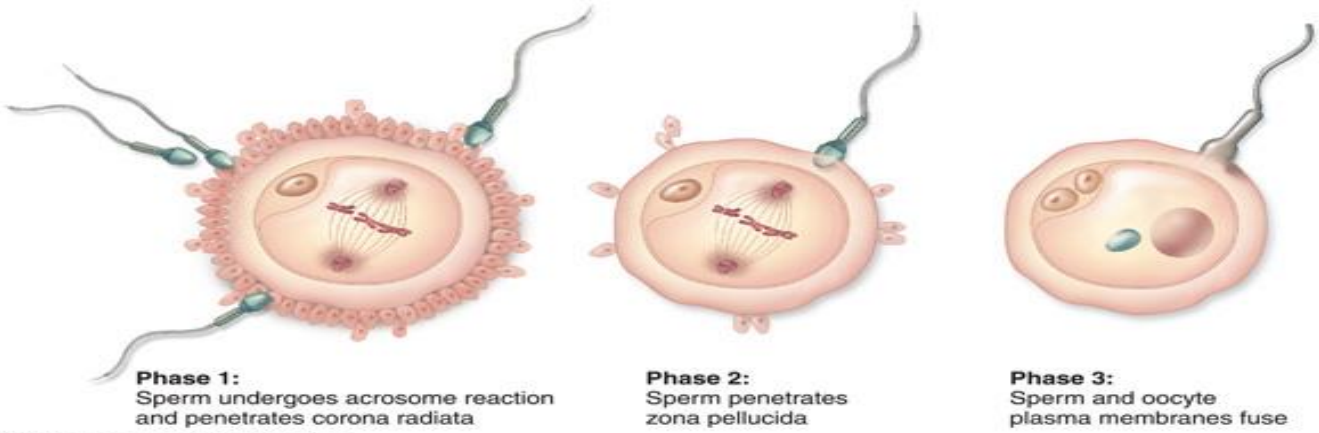
- Preparation is the first component of fertilization
  - Ovum released into fallopian tube
    - Viable for 24 hours
  - Sperm deposited into vagina
    - Viable for 48 to 72 hours (highly fertile for 24 hours)
  - Sperm must undergo capacitation and acrosomal reaction

Moment of Fertilization

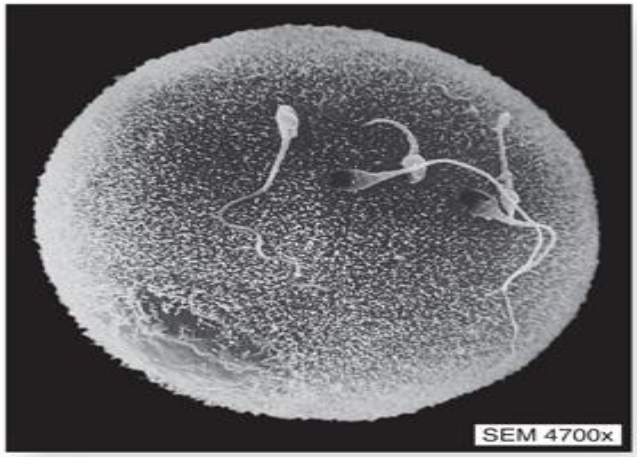
- Sperm penetration causes chemical reaction that blocks more sperm penetration
- Sperm enters ovum, chemical signal prompts secondary oocyte to complete second meiotic division
- True moment of fertilization occurs as nuclei unite

Fertilization

(a) Sperm cell

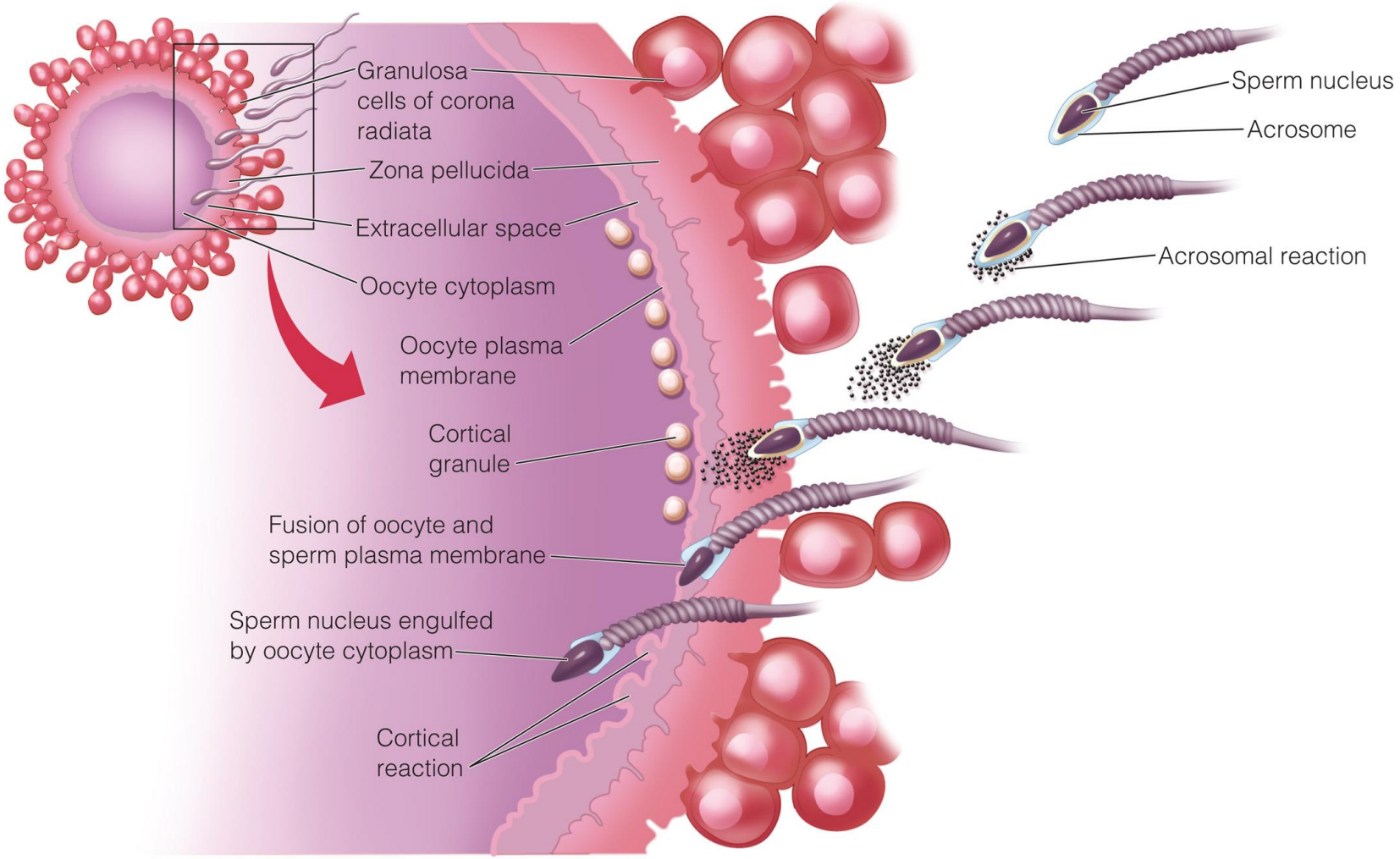


(b) Three phases of fertilization



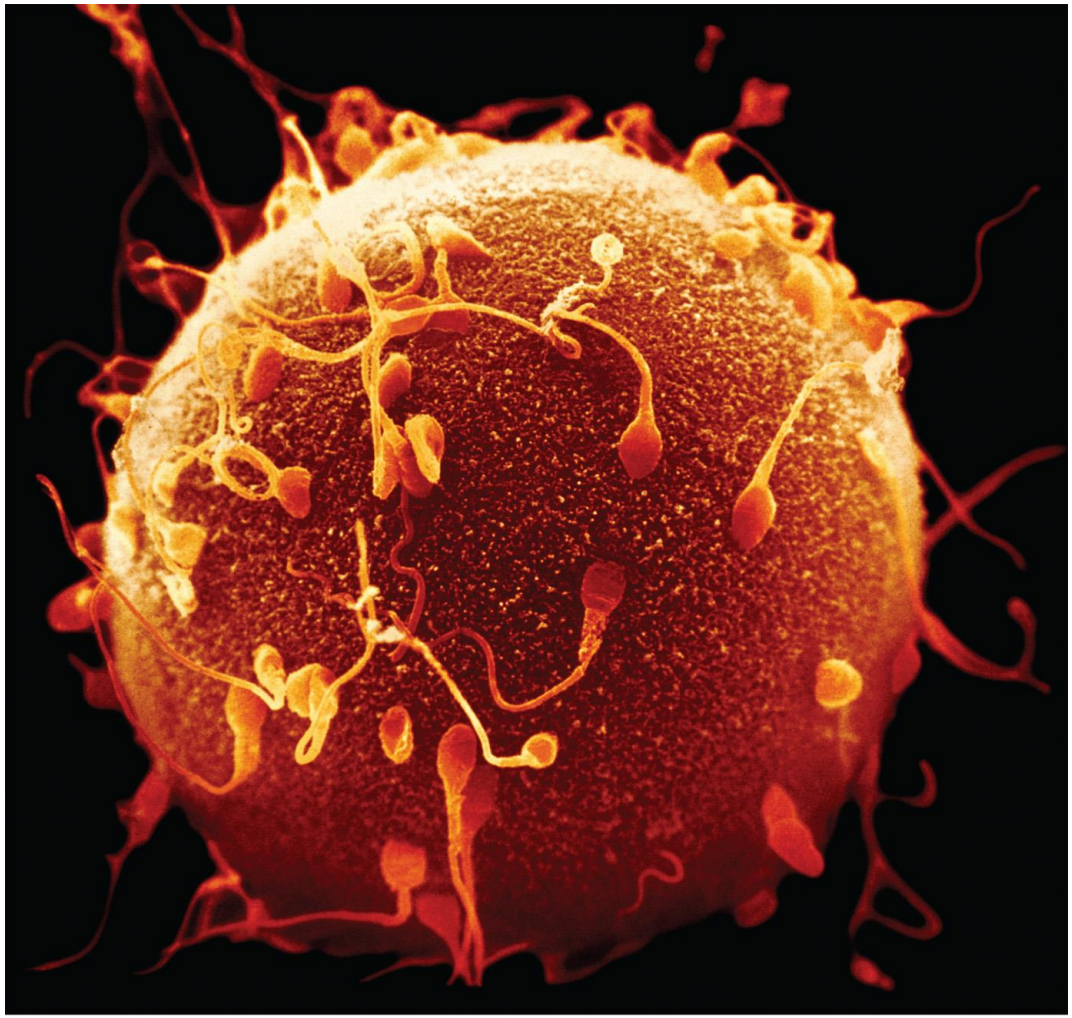
(c) Phase 1 of fertilization

Figure 4-2 Sperm penetration of an ovum. *A*, The sequential steps of oocyte penetration by a sperm are depicted moving from top to bottom.



A

Figure 4-2 (continued) Sperm penetration of an ovum. *B*, Scanning electron micrograph of a human sperm surrounding a human ovum (750X). The smaller spherical cells are granulosa cells of the corona radiata. *Source: © Phillips D/Photo Researchers/Getty Images.*

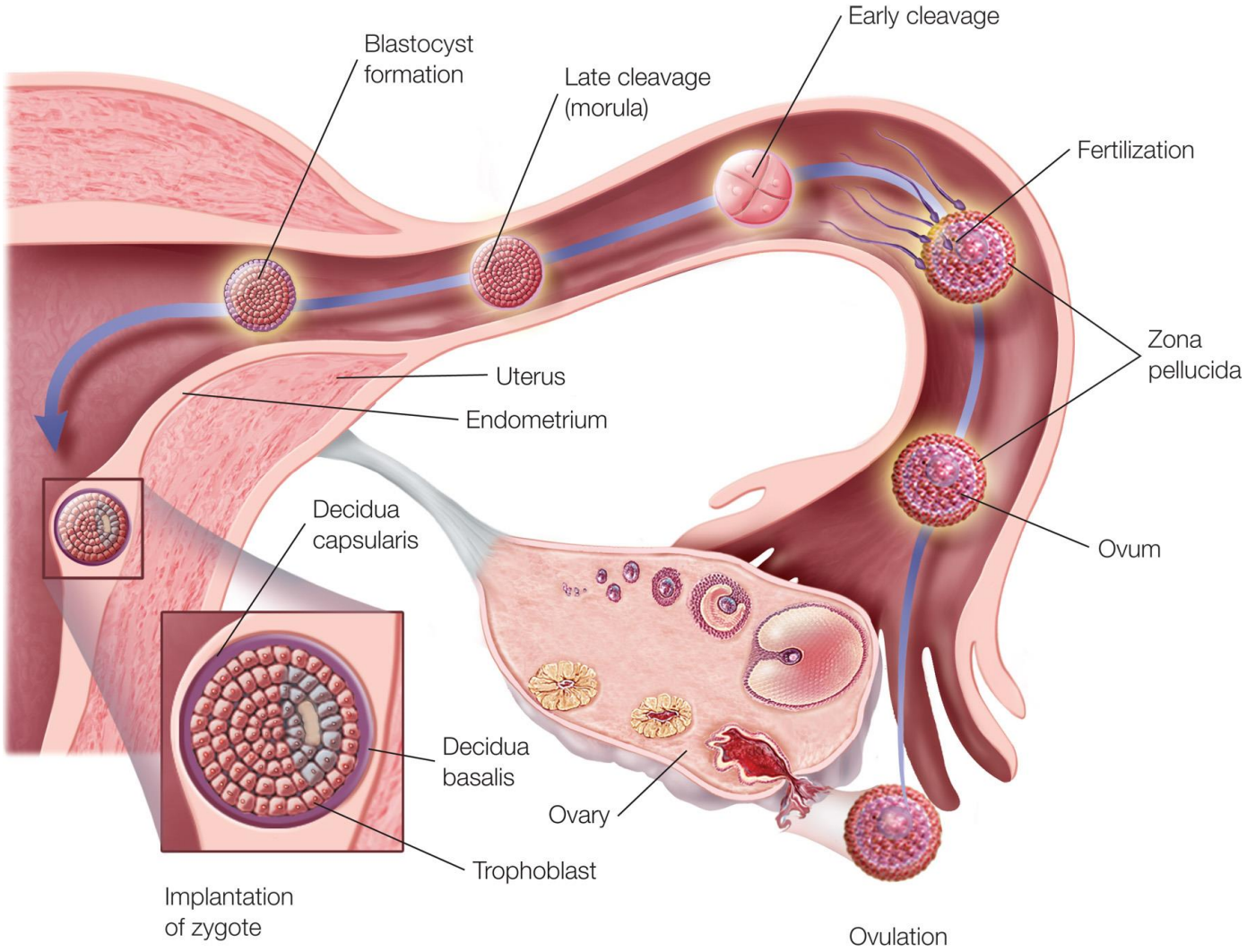


B

Moment of Fertilization

- Chromosomes pair up to produce diploid zygote (Germinal Period)
- Lasts about 2 weeks, from conception through implantation
- Zygote undergoes mitosis (cell duplication) as it travels down the fallopian tube to the uterus
- Approx. by 4th day after conception, the zygote has become a blastocyst (Fluid-filled ball of cells)

Figure 4-3 Changes in fertilized ovum from conception to implantation. During ovulation, the ovum leaves the ovary and enters the fallopian tube. Fertilization generally occurs in the outer third of the fallopian tube.



Moment of Fertilization

- Each nucleus contains haploid number of chromosomes (23)
- Union restores diploid number (46)
- 46 chromosomes in zygote = 46 chromosomes in both daughter cells
- Zygote contains new combination of genetic material

Moment of Fertilization

- Sex of zygote determined at moment of fertilization
- Two chromosomes of twenty-third pair (sex chromosomes)—either XX or XY—determine sex of individual
- Females have two X chromosomes, males have an X and a Y chromosome

Learning Outcome 4-4

Summarize the processes that occur during the cellular multiplication and differentiation stages of intrauterine development and their effects on the structures that form.

Cell Multiplication

- Rapid mitotic division
  - Cleavage

✓ Begins ~ 12 hours post-fertilization

✓ Zygote divides into 2 cells (mitosis)

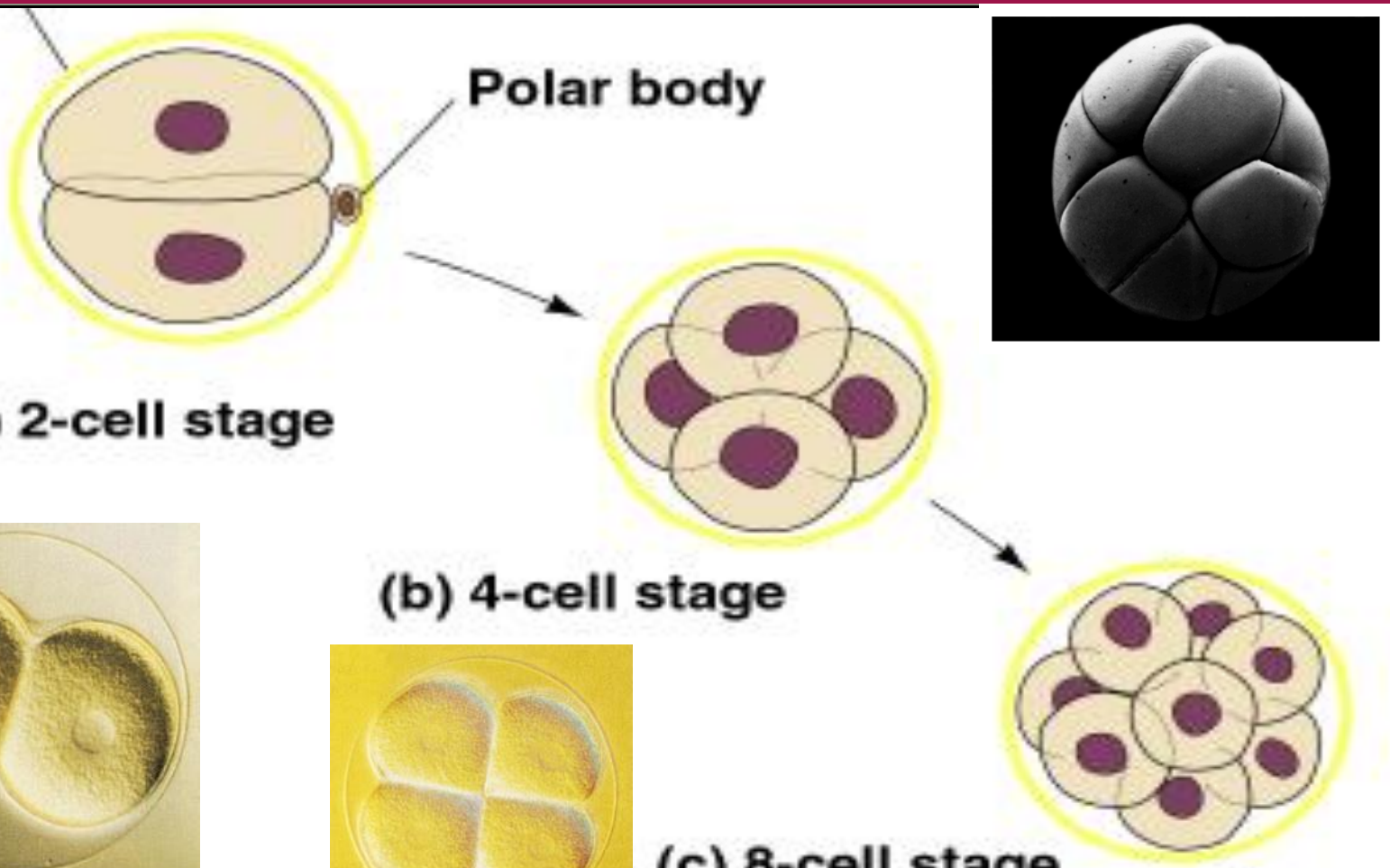
✓ 46 chromosomes in zygote = 46 chromosomes in both daughter cells

✓ 2 cell into 4 cell stage (24 – 36 hours)

✓ 4 cell into 8 cell stage (36 – 72 hours)

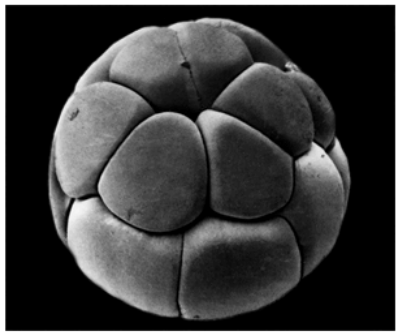
✓ 16 cell stage -- **Morula**

Cleavage

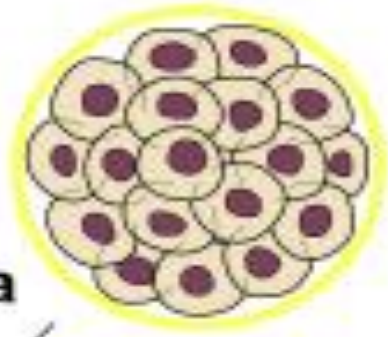


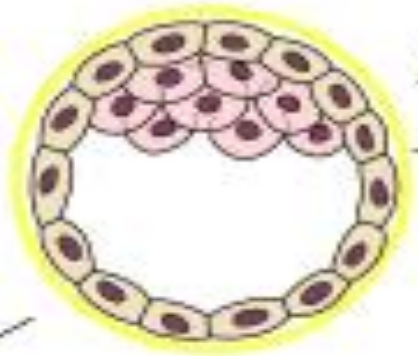
Cell Multiplication

- Blastomeres grow to morula (solid ball of 12 to 16 cells)
- Morula, once entering the uterine cavity, floats freely
- Morula begins to accumulate fluid & forms a cavity between its cells
- Morula divides into solid mass with a cavity (blastocyst); surrounded by outer layer of cells (trophoblast)
- Implantation; occurs in 7 to 10 days



(d) Morula

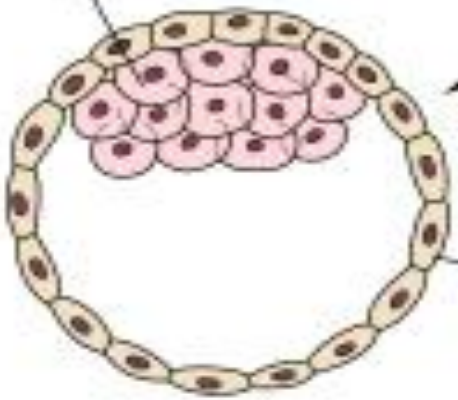




Zona pellucida begins to degenerate.

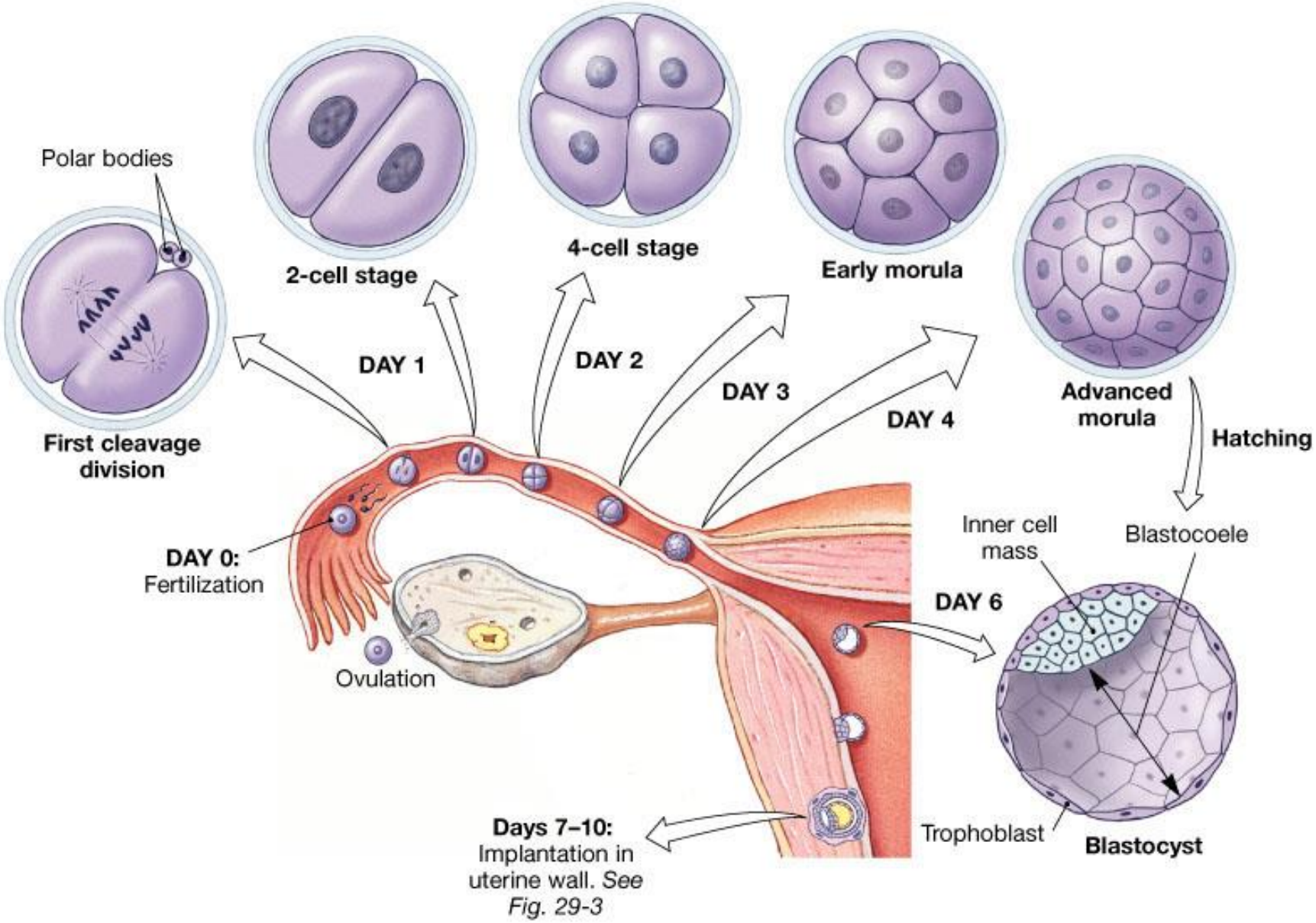
Inner cell mass

(e) Blastocyst (early)



Trophoblast

(f) Blastocyst (late)


Polar bodies
First cleavage division
2-cell stage
4-cell stage
Early morula
Advanced morula
Hatching
DAY 1
DAY 2
DAY 3
DAY 4
DAY 0:
Fertilization
Ovulation
DAY 6
Inner cell mass
Blastocoele
Trophoblast
Blastocyst
Days 7–10:
Implantation in uterine wall. See Fig. 29-3

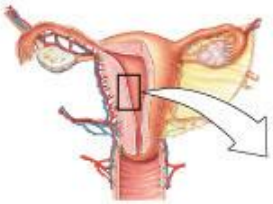
Cell Differentiation

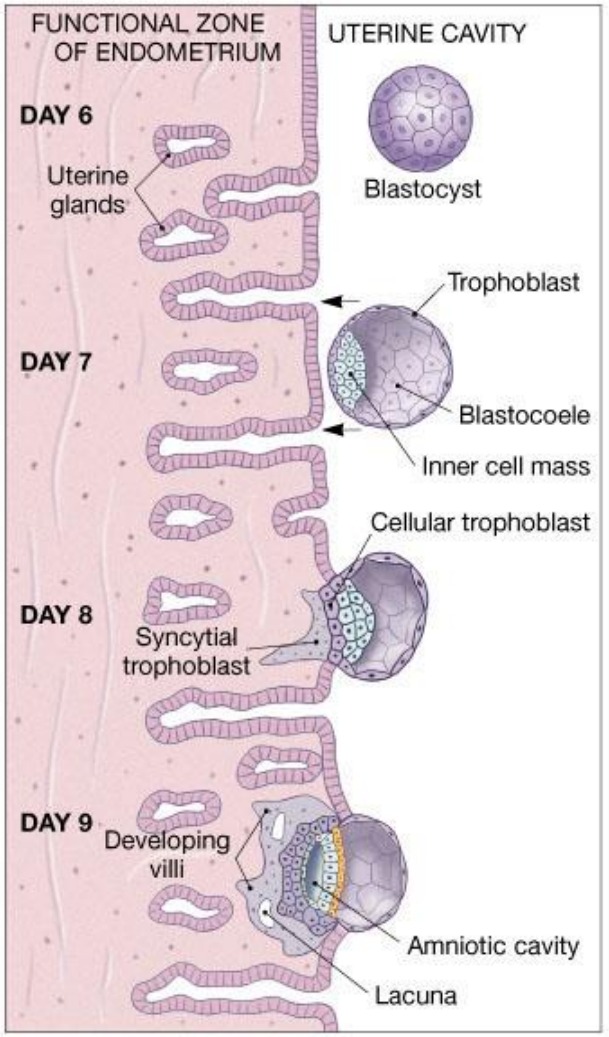
- 10 to 14 days (ectoderm, mesoderm, and endoderm) from which all tissues, organs, and organ systems develop
  - Blastocyst differentiates into three primary germ layers (ectoderm, mesoderm, and endoderm)
  - All tissues, organs, and organ systems develop from these primary germ cell layers

Implantation

Begins about the 6th day of development

- Trophoblast will help form the placenta
- Trophoblast secretes hCG which helps maintain the pregnancy





Human Chorionic Gonadotropin (HCG)

- hCG is a hormone, produced by the trophoblasts starting on day 6
- Causes endometrium of uterus to grow and proliferate
- Prevents the menstrual cycle from occurring

Cell Differentiation

- Embryonic membranes form at implantation
  - The chorion and the amnion

Table 4–2 Derivation of Body Structures from Primary Cell Layers

Ectoderm	Mesoderm	Endoderm
Epidermis	Dermis	Respiratory tract epithelium
Sweat glands	Wall of digestive tract	Epithelium (except nasal), including pharynx, tongue, tonsils, thyroid, parathyroid, thymus, tympanic cavity
Sebaceous glands	Kidneys and ureter (suprarenal cortex)	
Nails	Reproductive organs (gonads, genital ducts)	Lining of digestive tract
Hair follicles	Connective tissue (cartilage, bone, joint cavities)	Primary tissue of liver and pancreas
Lens of eye	Skeleton	Urethra and associated glands
Sensory epithelium of internal and external ear, nasal cavity, sinuses, mouth, anal canal	Muscles (all types)	Urinary bladder (except trigone)
Central and peripheral nervous systems	Cardiovascular system (heart, arteries, veins, blood, bone marrow)	Vagina (parts)
Nasal cavity	Pleura	
Oral glands and tooth enamel	Lymphatic tissue and cells	
Pituitary gland	Spleen	
Mammary glands		

Cell Differentiation

- Amniotic Fluid
  - Created when amnion and chorion grow and connect and form amniotic sac to produce fluid
- Yolk sac
  - Develops as part of the blastocyst 8-9 days post fertilization
  - Produces primitive red blood cells & transports nutrients to embryo
  - Soon incorporated into the umbilical cord

Functions of amniotic fluid

Homework ☺

Early Embryonic Stage

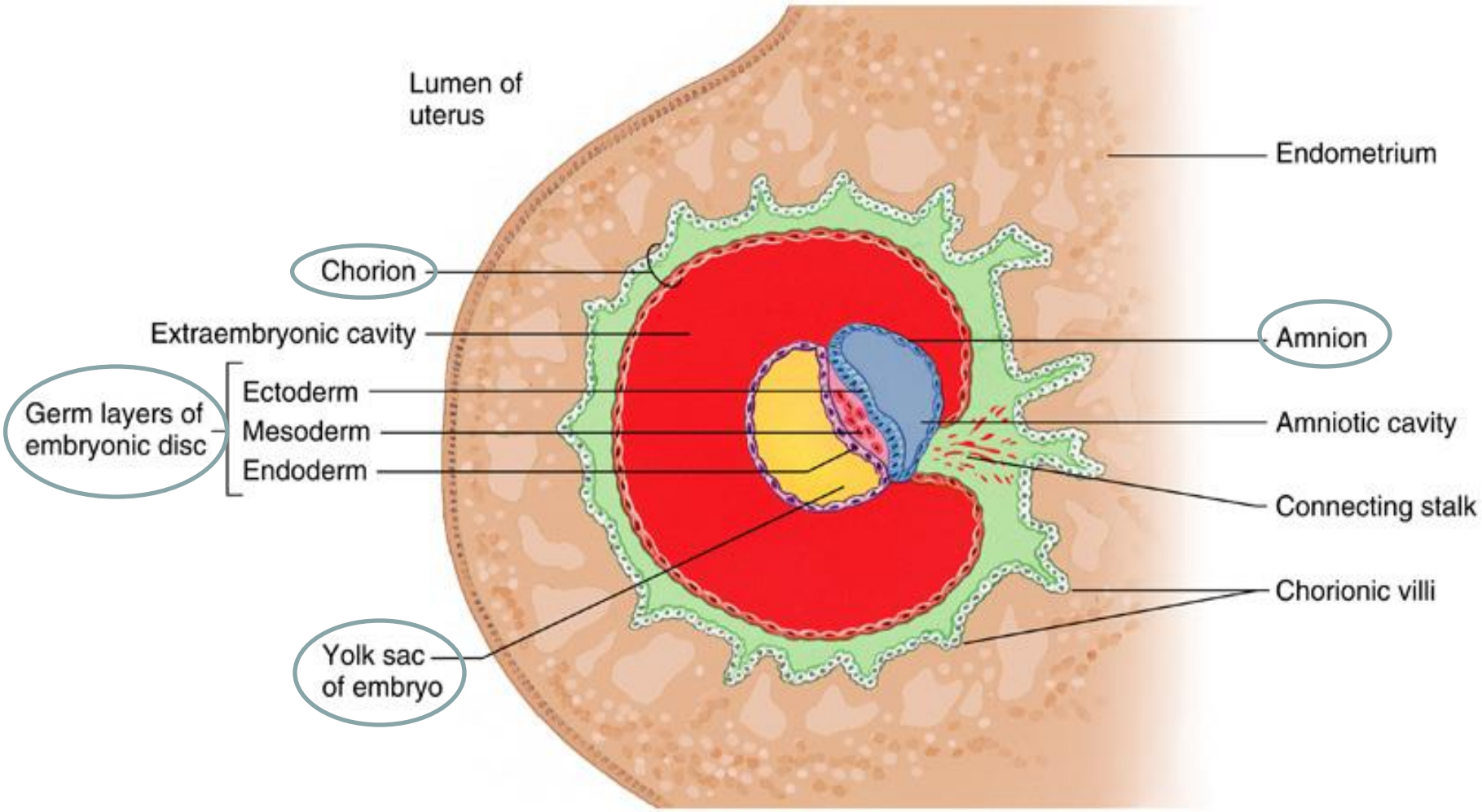
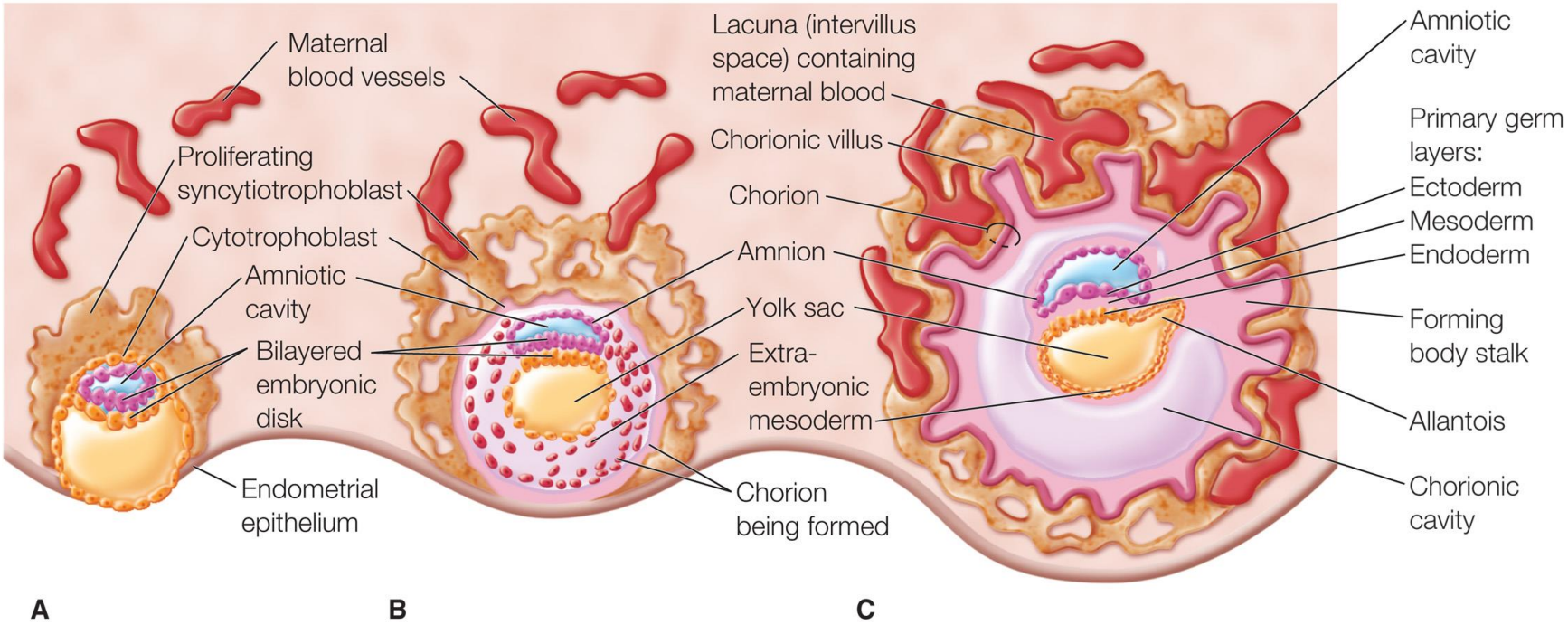


Figure 4-4 Formation of primary germ layers. *A*, Implantation of a 7½-day blastocyst in which the cells of the embryonic disk are separated from the amnion by a fluid-filled space. The erosion of the endometrium by the syncytiotrophoblast is ongoing. *B*, Implantation is completed by day 9, and extraembryonic mesoderm is beginning to form a discrete layer beneath the cytotrophoblast. *C*, By day 16 the embryo shows all three germ layers, a yolk sac, and an allantois (an outpouching of the yolk sac that forms the structural basis of the body stalk, or umbilical cord). The cytotrophoblast and associated mesoderm have become the chorion, and chorionic villi are developing.

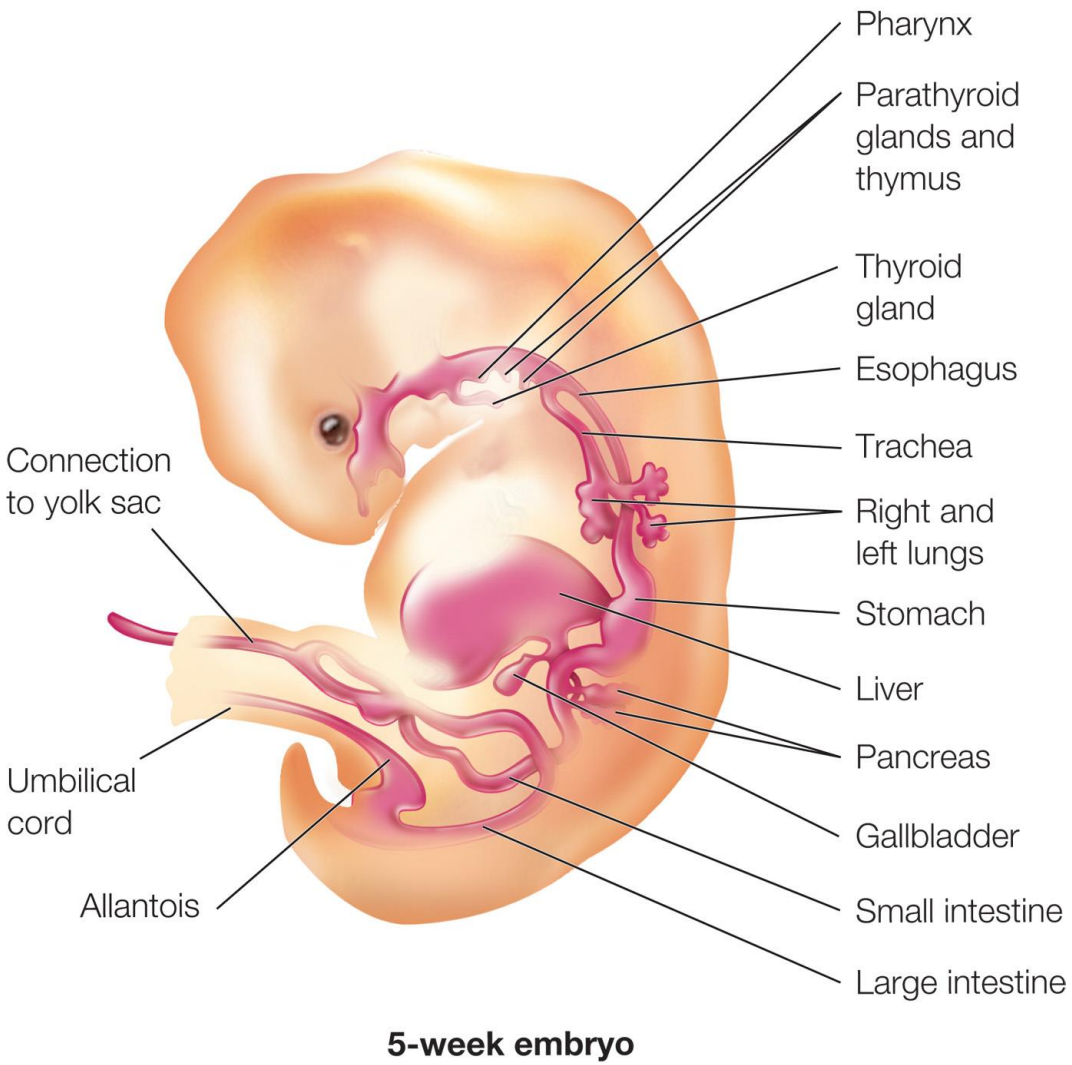


Cell Differentiation

By 2 weeks post-conception, inner cell mass has differentiated into 3 layers of cells:

- Ectoderm: nervous system, outer layer of skin, nails, teeth, ears, eyes
- Mesoderm: muscles, skeleton, circulatory system, inner layers of skin
- Endoderm: digestive system, lungs, urinary tract, glands

Figure 4-5 Differentiation of endoderm. Endoderm differentiates to form the epithelial lining of the digestive and respiratory tracts and associated glands.



Learning Outcome 4-5

Describe the development, structure, and functions of the placenta and umbilical cord during intrauterine life (embryonic and fetal development).

Umbilical Cord

- Develops from amnion
  - Body stalk attaches embryo to yolk sac, fuses with embryonic portion of placenta
  - Provides pathway from chorionic villi to embryo

Umbilical Cord

- Contains two arteries and one vein; surrounded by Wharton's jelly to protect vessels
  - Wharton's jelly
    - Specialized connective tissue
  - Protects blood vessels
- Function of umbilical cord
  - Provides circulatory pathway to embryo

Umbilical cord

- Umbilical cord is usually twisted or spiraled due to fetal movement
- True knot: rare. If occurred, the cord is usually longer than usual
- Nucheal cord: when the Umbilical cord encircles the fetal neck

Placenta

- Placental development
  - Begins at third week of embryonic development
  - Develops at site where embryo attaches to uterine wall
  - Connected to the embryo by the umbilical cord

Placenta

- Function
  - Metabolic, nutrient & gas exchange between embryonic and maternal circulations
  - Excretion of wastes as kidney
  - Conjunction of drugs & hormones as liver
  - Protects to the embryo by preventing some substances from reaching the embryo's bloodstream

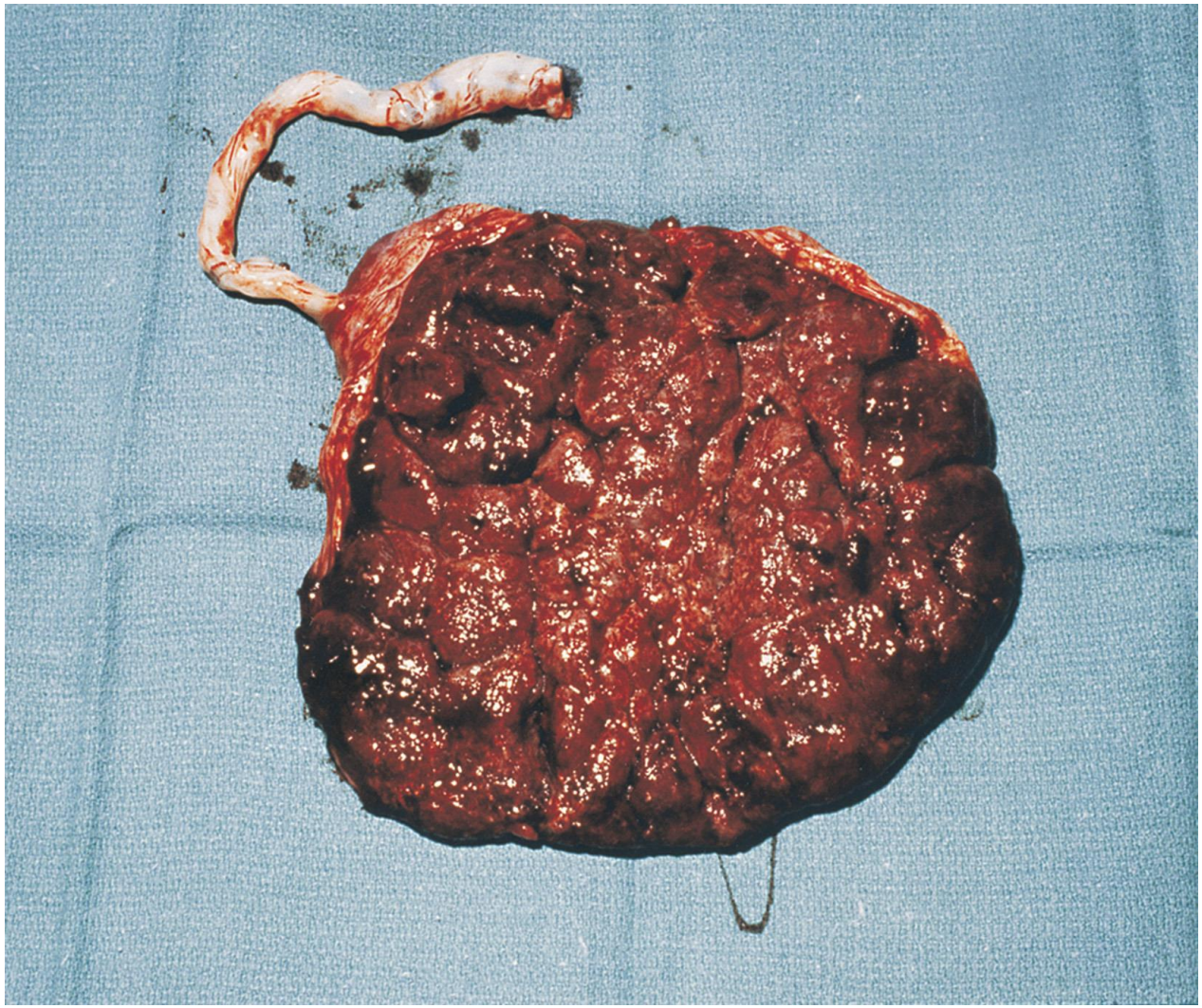
Placenta

- Placenta has two parts
  - Maternal
  - Fetal

Placenta

- Maternal portion
  - Red, flesh-like, rough, irregular, made up of chorionic villi, contain 30 lobes named cotyledons
  - Consists of decidua basalis and its circulation

Figure 4-8 Maternal side of placenta. *Source: Courtesy of M. London.*



Placenta

- Fetal portion
  - Smooth regular surface, appears shiny and gray
  - Consists of the chorionic villi and their circulation
  - The fetal surface of the placenta is covered by the amnion

Figure 4-9 Fetal side of placenta. *Source: Courtesy of M. London.*

Formation of Twins

HOMEWORK ☺

Learning Outcome 4-7

Summarize the significant changes in growth and development of the fetus at 4, 6, 12, 16, 20, 24, 28, 36, and 40 weeks' gestation.

Figure 4-12 The embryo at 5 weeks. The embryo has a marked C-shaped body and a rudimentary tail.
Source: Omikron Omikron/Getty Images

Fetus Growth and Development

- 4 weeks
  - 4-6 mm, brain formed from anterior neural tube, limb buds seen, heart beats, GI system begins
- 6 weeks
  - 12 mm, primitive skeletal shape, chambers in heart, respiratory system begins, ear formation begins

Fetus Growth and Development

- 12 weeks
  - 8 cm, ossification of skeleton begins, liver produces red cells, palate complete in mouth, skin pink, thyroid hormone present, insulin present in pancreas
- 16 weeks
  - 13.5 cm, teeth begin to form, meconium begins to collect in intestines, kidneys assume shape, hair present on scalp

Fetus Growth and Development

- 20 weeks
  - 19 cm, myelination of spinal cord begins, suck and swallow begins, lanugo covers body, vernix begins to protect the body
- Surfactant production begins, brain appears mature

Figure 4-16 The fetus at 20 weeks. The fetus now weighs 435 to 465 g (15.2 to 16.3 oz) and measures about 19 cm (7.5 in.). Subcutaneous deposits of brown fat make the skin a little less transparent. "Woolly" hair may cover the head, and nails have developed on the fingers and toes. *Source: James Stevenson/Science Source*

Fetus Growth and Development

- 28 weeks
  - 27 cm, nervous system begins regulation of some functions, adipose tissue accumulates; nails, eyebrows, and eyelids are present; eyes are open
- 36 weeks
  - 35 cm, earlobes soft with little cartilage, few sole creases

Fetus Growth and Development

- 40 weeks
  - 40 cm, adequate surfactant, vernix in skin folds and lanugo on shoulders, earlobes firm, sex apparent
    - Weight about 3,000 to 3,600 g (6 lb., 10 oz. to 7 lb., 15 oz.)
    - Varies in different ethnic groups
    - Skin has a smooth, polished look
    - Hair on head is coarse and about 1 inch long
    - Body and extremities are plump

Table 4–4 Fetal Development: What Parents Want to Know

4 weeks:	The fetal heart begins to beat.
8 weeks:	All body organs are formed.
8 to 12 weeks:	Fetal heart rate can be heard by ultrasound Doppler device.
16 weeks:	Baby's sex can be seen. Although thin, the fetus looks like a baby.
20 weeks:	Heartbeat can be heard with fetoscope. Mother feels movement (quickening). Baby develops a regular schedule of sleeping, sucking, and kicking. Hands can grasp. Baby assumes a favorite position in utero. Vernix (lanolinlike covering) protects the body, and lanugo (fine hair) keeps oil on skin. Head hair, eyebrows, and eyelashes present.
24 weeks:	Weighs 780 g (1 lb, 10 oz). Activity is increasing. Fetal respiratory movements begin. Baby makes sucking movements.
28 weeks:	Eyes open and close. Baby can breathe at this time. Surfactant needed for breathing at birth is formed. Baby is two thirds its final length.
32 weeks:	Baby has fingernails and toenails. Subcutaneous fat is being laid down. Baby appears less red and wrinkled.
38+ weeks:	Baby fills total uterus. Baby gets antibodies from mother.

Learning Outcome 4-8

Identify the factors that influence congenital malformations of the various organ systems.

Teratogenesis

- Embryo is most vulnerable to teratogenesis during the first 8 weeks of cell differentiation and organ system development. Effects of teratogens depend on the:
  - Maternal and fetal genotype
  - Stage of development when exposure occurs
  - Dose and duration of exposure of the agent

Fertilization to implantation

- https://www.youtube.com/watch?v=btp4jCYZ5K4

END