

CHAPTER 23: HUMAN GROWTH AND DEVELOPMENT

1. Define the term *fertilization* and name the site where fertilization typically occurs.
2. Explain what is meant by capacitation of a sperm.
3. Describe the structure of a secondary oocyte when it is ovulated from the ovary.
4. Define syngamy and explain how and why it occurs.
5. List the components of a zygote.
6. Define the term *cleavage* and explain why the cells (blastomeres) are unable to grow between divisions.
7. Define the term *morula*, describe its structure, and state the approximate time-table for its appearance.
8. Define the term *blastocyst*, describe its structure, and state the approximate time-table for its appearance.
9. Distinguish between trophoblast, inner cell mass (ICM) and blastocoel, in terms of their location in the blastocyst.
10. Define the term *implantation*, and name the structure that the blastocyst must lose before it can occur.
11. Distinguish between the cytotrophoblast and the syncytiotrophoblast, in terms of their structure, location and function.
12. Explain how the implanted blastocyst is nourished until the endometrial blood vessels have been penetrated.
13. Distinguish between the decidua basalis, decidua capsularis, and decidua parietalis in terms of the location and function.
14. State the time when an embryo is considered a fetus.
15. Define the term *gastrulation*, name the portion of the blastocyst that undergoes gastrulation, and name the approximate time at which gastrulation is complete.
16. Define the terms *amnion & amniotic cavity*, and name the approximate time when they are formed.

CHAPTER 23: HUMAN GROWTH AND DEVELOPMENT Objectives (continued)

17. Compare and contrast the terms ectoderm, endoderm, and mesoderm, in terms of their location on a gastrula diagram, and the adult body tissue(s) that each gives rise to.
18. Name the primary germ layer from which the yolk sac arises.
19. When the mesoderm splits, name the space or cavity that results.
20. List the four extraembryonic membranes, identify each on a diagram, name the function(s) of each, and describe the fate of each.
21. Describe the structure of the placenta in terms of the fetal portion with its extensions and the maternal portion with its blood filled spaces.
22. Discuss the functions of the placenta and describe what becomes of it after delivery.
23. List the things that can pass through the placenta and those that cannot.
24. Describe the structure of the umbilical cord in terms of blood vessels, the direction in which blood is flowing through those vessels, and supporting CT.
25. Discuss the function of the umbilical cord and explain what becomes of it at (after) birth.
26. Fully describe the three types of prenatal testing currently performed.
27. Define the term *karyotype* and discuss the type of information that may be obtained by one.
28. Name and discuss the major hormones involved with the onset of labor and birth.
29. List the three stages of birth and describe the events that occur within each.
30. Discuss the "fight-or-flight" response of a newborn.
31. Define the term *puerperium* and discuss the major events that occur during this time.

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I. INTRODUCTION

Developmental anatomy is the study of events from fertilization of the secondary oocyte to the formation of an adult organism. In this chapter we will study the sequence of events from fertilization to birth which include fertilization, implantation, placental development, embryonic development, fetal growth, gestation, parturition, and labor.

II. DEVELOPMENT DURING PREGNANCY

Pregnancy includes a sequence of events including fertilization, implantation, embryonic growth, and fetal growth that finally results in birth.

A. **Fertilization** = fusion of genetic material from sperm and ovum into a single nucleus; (Review from Chapter 22)

1. Sperm become fully **capacitated** within female reproductive tract (i.e. acrosome secretes digestive enzymes to break through corona radiata).
2. Secondary oocyte is ovulated from ovary surrounded by a **zona pellucida** and **corona radiata** (nutritive granulosa cells).
3. Usually in the **fallopian tube**, sperm bind to the zona pellucida, but only one sperm penetrates and enters the secondary oocyte (i.e. **syngamy**):
 - a. depolarization of oocyte cell membrane;
 - b. calcium ions rush in (and from within);
 - c. granules are released from oocyte;
 - d. causing oocyte cell membrane to become impermeable to other sperm.
 - e. Prevents polyspermy.
4. Once the sperm has entered a secondary oocyte:
 - a. Meiosis II occurs (forming **female pronucleus** = 23 chromosomes [i.e. haploid; 1n]);
 - b. Sperm's tail is shed (forming **male pronucleus** = 23 chromosomes [i.e. haploid; 1n]);
 - c. Pronuclei fuse forming a **segmentation nucleus** (= 46 chromosomes; 2n);
 - d. **Zygote** = segmentation nucleus, cytoplasm, and the zona pellucida.

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II. Development during Pregnancy (continued)

B. Formation of the Morula

See Fig 23.2, page 893 and Fig 23.3a and c, page 895.

1. **Cleavage** = the early series of mitotic divisions of the zygote.
 - a. These divisions occur so rapidly, that the cells are unable to grow between divisions.
 - b. The mass of successively smaller and smaller cells is still contained within the zona pellucida.
 - c. These small cells are called **blastomeres**.
2. First division = 36 hours = 2 cells.
3. Second division = 48 hours = 4 cells.
4. **Morula** = solid ball of 32 cells (resembles a raspberry); about 96 hours.

C. Formation of the Blastocyst (Fig 23.3b, page 895)

1. **Blastocyst** = a hollow ball of cells surrounding a central cavity; about 5 days.
 - a. **Trophoblast** = outer covering of cells (just beneath the zona pellucida);
 - m This will become the **chorion** which forms the fetal portion of the **placenta**.
 - b. **Inner Cell Mass (ICM)** = cells concentrated in one portion of the inner cavity;
 - m These cells will contribute to the formation of the embryonic body.
 - c. **Blastocoel** = internal fluid-filled cavity.

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II. Development during Pregnancy (continued)

D. **Implantation** (See Fig 23.4a, b, & c, page 896)

1. The blastocyst floats freely in the uterus for a few days during which time the zona pellucida disintegrates.
2. At about 6 days, the blastocyst adheres to the endometrium = **implantation**.
 - a. The blastocyst adheres to the uterine wall with the ICM oriented toward the endometrium.
3. The trophoblast develops into two distinct layers:
 - a. **Cytotrophoblast** that is composed of distinct boundary cells (i.e. perimeter cells);
 - b. **Syncytiotrophoblast** that is in closest contact with the endometrium and contains no cell boundaries.
 - m secretes enzymes that break down mucosa of endometrium for implantation;
 - m Digested endometrial cells serve as nourishment for burrowing blastocyst for about one week;
4. Eventually the blastocyst becomes buried within the endometrium.
 - a. **Decidua basalis** = the endometrium just beneath the blastocyst.
 - b. **Decidua capsularis** = the endometrium that surrounds the rest of the burrowed blastocyst.

* Add this layer to Fig 23.4b, page 896.

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III. EMBRYONIC DEVELOPMENT

A. Introduction:

1. Embryonic development is considered the first eight weeks of development.
 - a. **Embryo** (bryein) = to grow.
 - b. **Embryology** = the study of development from fertilization through the eighth week.
 - c. Developments:
 - m Rudiments of all principle adult organs are present.
 - m Embryonic membranes have formed.
2. **Fetal period** = development from 8 weeks 'til birth.
 - a. **Fetus** (feo) = to bring forth.
 - b. By end of third month, the placenta is functioning.

B. Beginning of Organ Systems:

1. **Gastrulation** = the development of three distinct primary germ layers (from which all body tissues will develop) occurs within the blastocyst, now termed the **gastrula**.
 - a. develop from ICM of blastocyst.
 - b. occurs by the completion of implantation.
2. Sequence of Events: **See Fig 23.6, page 897.**
 - a. Top layer of ICM cells proliferates and forms the **amnion** (a fetal membrane) and a space, the **amniotic cavity** over the ICM; 8 days.
 1. The **Ectoderm** is the layer of cells of the ICM that is closest to the amniotic cavity.
 - a. considered the outer most germ layer;
 - b. will form the outer covering (i.e. epidermis) and CNS organs in the adult.

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B. Beginning of Organ Systems (continued)

2. Sequence of events (continued)

See Fig 23.6, page 897.

a. 8 days (continued)

2. The **Endoderm** is the layer of ICM cells that border the blastocoele.

m considered the innermost germ layer;

m will form the inner lining (mucosa) of the adult (i.e. digestive, urinary tracts) and some internal organs;

m At this point, the ectoderm and endoderm are considered the **embryonic disc** (i.e. will become the embryonic body).

b. Striking changes appear about Day 12:

1. The endoderm grows and forms the **yolk sac** (a fetal membrane).

2. **Mesoderm** develops between the endoderm and ectoderm.

m considered the middle germ layer;

m will form most of the muscles and bones in the adult and many other internal organs.

m At about Day 14:

- a. The **mesoderm** splits into two layers with the space between them called the **extraembryonic coelom**.

* See Fig 23.7, page 900 to illustrate how the germ layers give rise to adult tissues.

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III. Embryonic development (continued)

C. Development of (**Extra**) **Embryonic Membranes**

These membranes lie outside the embryo, & protect and nourish the embryo (and fetus). See Fig 23.14, page 904.

1. The **yolk sac**:

- a. endodermal lined;
- b. primary source of nourishment in embryo;
- c. early site of blood cell formation;
- d. becomes a non-functional portion of the umbilical cord.

2. The **amnion**

- a. a thin protective membrane that forms about Day 8;
- b. encases the young embryonic body creating a cavity that becomes filled with **amniotic fluid**.

m serves as shock absorber for fetus;

m helps regulate fetal temperature;

m prevents adhesions between skin of fetus and other tissues;

m Fetal cells slough off into this fluid and may be removed during a procedure called an **amniocentesis** (See page 925).

- c. eventually fuses with and becomes the inner lining of the chorion (below).

3. The **chorion**

- a. develops from the trophoblast of the blastocyst;
- b. surrounds the embryo/fetus;
- c. becomes the principle embryonic portion of the placenta.

4. The **allantois**

- a. a small vascularized outpocketing of the yolk-sac;
- b. early site of blood cell formation;
- c. Its blood vessels eventually will form connections within the placenta (i.e. this connection = the **umbilical cord**).

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III. Embryonic Development (continued)

D. Placenta & Umbilical Cord

See Fig 23.13, page 904, Fig 23.15, page 905.

Development of the placenta is complete by the third month of pregnancy.

1. Anatomy of the Placenta:
 - a. shaped as a flat cake when mature;
 - b. The **embryonic (fetal) portion** of the placenta = **chorion**.
 - m Note the location and structure of the finger-like **chorionic villi** (containing fetal blood vessels from the allantois) that extend into **intervillous spaces** (maternal blood sinuses).
 - m This is the exchange site.
 - c. The **maternal portion** = a portion of the endometrium called the **decidua basalis**.
 - o Note location of decidua capsularis and decidua parietalis also.
2. Physiology of the Placenta:
 - a. serves to **maintain fetus**:
 - m Oxygen and nutrients diffuse into fetal blood from maternal blood;
 - m Carbon dioxide and wastes diffuse from fetal blood into maternal blood;
 - * Nearly all drugs pass freely through the placenta.
 - b. serves as a **protective barrier** against most microorganisms
 - m permeable to the viruses that cause AIDS, German measles, chicken-pox, measles, encephalitis, & poliomyelitis
 - c. serves to **maintain pregnancy** via secretion of hormones.
3. At delivery, the placenta detaches from the uterus and is termed the "**after birth**".

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III. Embryonic Development (continued)

D. Placenta and Umbilical Cord (continued)

See Fig 23.13, page 904, Fig 23.15, page 905.

3. The **umbilical cord**

- a. vascular connection between fetus and mother:
 - m **one umbilical vein** which carries blood rich in nutrients and oxygen to the fetus from the placenta;
 - m two **umbilical arteries** that carry carbon dioxide and wastes away from the fetus to the placenta.
 - * The above vessels meet at the **umbilicus** (navel) where the arteries wrap around the vein within the umbilical cord.
 - m Wharton's Jelly = supporting mucous CT from allantois.
- b. completely surrounded by a layer of amnion.
- c. At delivery, umbilical cord is severed, leaving baby on its own (i.e. resulting scar = navel).

IV. FETAL GROWTH

See Figure 23.10, page 902 through Figure 23.18, page 907.

See Summary Table 23.1 of Events on page 911.

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V. PRENATAL DIAGNOSTIC TESTS

A. Fetal Ultrasonography:

1. most commonly used to determine **fetal age** but can also evaluate fetal viability, growth, position, #, placental/umbilical abnormalities;
2. Instrument emits sound waves; reflection is collected and is then converted to an image on a screen = **sonogram**.

B. Amniocentesis:

1. Amniotic fluid (containing sloughed fetal cells) is withdrawn from amniotic sac;
2. Cells are analyzed by **Karyotyping** to detect genetic (chromosome structure) abnormalities;
3. Useful in detecting genetic disorders including **Down Syndrome**, spina bifida, hemophilia, Tay-Sachs disease, sickle-cell anemia, and some muscular dystrophies.
4. Indicated in mothers 35 and over, couples with genetic disposition to diseases above;
5. performed at about **14-16 weeks gestation**;
6. Removed fluid may also be biochemically tested for alphafetoprotein (AFP) and acetylcholine which indicate neural tube disorders;
7. 0.5% spontaneous abortion rate.

C. Chorionic Villus Sampling:

1. determines same defects as amniocentesis;
2. performed as early as 8 weeks;
3. 1-2% spontaneous abortion rate.

VIII. PARTURITION (Birth) AND LABOR

A. Onset of labor is unknown, but is thought to depend on many factors:

1. Placental & ovarian hormones seem to play a role in the rhythmic & forceful uterine contractions;
2. Prostaglandins may also play a role.
3. **Oxytocin (OT)** from posterior pituitary stimulates contraction.
4. **Relaxin** relaxes the pubic symphysis and dilates the cervix to aid in delivery.

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VIII. Parturition & Labor (continued)

B. Labor is divided into three stages:

1. **Stage of Dilation** = the time from onset of labor to complete dilation of the cervix.
 - a. regular contractions;
 - b. rupture of amniotic sac;
 - c. complete dilation = 10cm.
2. **Stage of Expulsion** = the time from complete cervical dilation to delivery.
3. **Placental Stage** = the time after delivery until the placenta ("after birth") is expelled.
 - a. regular contractions;
 - b. constriction of blood vessels to reduce chance of hemorrhage.

C. "Fight-or-Flight" Response of Baby

1. Fetal head compression during birth leads to intermittent **hypoxia**;
2. The baby responds by secreting high levels of **epinephrine and norepinephrine** (adrenal medulla);
 - a. provide protection against the stresses of birth;
 - b. prepares the infant to survive extra-uterine life.
 - c. Actions include:
 - m clearing of lungs for breathing outside uterus;
 - m mobilizes nutrients for metabolism;
 - m promotes a rich vascular supply to brain & heart.

D. Puerperium = the six weeks following birth.

1. Period where the maternal reproductive organs and physiology return to the pre-pregnancy state.
2. Process of tissue catabolism of the uterus occurs called **involution**.
3. Uterine (placental) discharge called **lochia** (blood plus mucous) continues for about 4 weeks.

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IX STAGES OF LIFE (pages 918-921)

- A. Infancy
- B. Adolescence
- C. Adulthood
- D. Senescence

See Table 23.5, page 922.

X. AGING (pages 922-924)

- A. Passive Aging
- B. Active Aging
- C. The Human Life span

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EXTRAS concerning Pregnancy & Birth

- A. Preimplantation Genetic Diagnosis (See CA 23.1, page 894)
- B. Twins (see box on page 895)
- C. Chorionic Villus Sampling (see box on page 897)
- D. Assisted Reproductive Technologies (See CA 23.2, page 898-899)
- E. Newborn Addiction (see box on page 905)
- F. Amniocentesis (see box on page 907)
- G. Some causes of birth defects (See CA 23.3, page 908-909)
- H. Joined for life (i.e. Siamese Twins, CA 23.4, page 916)
- I. Patent Ductus Arteriosus (see box on page 917)
- J. Physician Assisted Suicide (see box on page 922)
- K. Hutchinson-Gilford Syndrome (See CA 23.5, page 924)