Al-Mustaqbal
university/Nursing college

Fetal Development

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KEY TERMS

age of viability (p. 38)

amniotic sac (ăm-nē-Ŏ-tĭk SĂK, p. 37)

autosomes (p. 33)

chorion (KŌ-rē-ŏn, p. 37)

decidua (dĕ-SĬD-yū-ă, p. 37)

diploid (DĬP-loid, p. 33)

dizygotic (DZ) (dī-zī-GŎT-ĭk, p. 44)

fertilization (p. 34)

gametogenesis (găm-ĕ-tō-JĔN-ĕ-ĭs, p. 34)

germ layers (p. 37)

haploid (HĂP-loid, p. 34)

monozygotic (MZ) (mŏn-ō-zī-GŎT-ĭk, p. 44)

oogenesis (ō-ō-JĔN-ĕ-sĭs, p. 33)

placenta (plă-SĔN-tă, p. 39)

spermatogenesis (spŭr-mă-tō-JĔN-ĕ-sĭs, p. 33)

teratogens (TĔR-ă-tō-jĕnz, p. 33)

Wharton jelly (p. 42)

1.Life begins with a single cell created by the fusion of a sperm and an ovum.
2.This single cell contains Deoxyribonucleic acid (DNA).
3.DNA programs a genetic code into the nucleus of the cell.
4.The nucleus controls the development and function of the cell.
5.The genes and chromosomes within the DNA determine the uniqueness of traits and features in the developing person.
6.Defects in the DNA code can result in inherited disorders.
7.The human body contains millions of cells at birth, each programmed by the DNA code.

Question:
What is the role of Deoxyribonucleic acid (DNA) in the development of a human being?
A) DNA determines the uniqueness of traits and features
B) DNA is responsible for cell division only
C) DNA is found outside the nucleus of the cell
D) DNA has no role in genetic disorders
Answer:
A) DNA determines the uniqueness of traits and features

Factors Influencing Prenatal Growth and Development:

1.External Environmental Influences:

1. Maternal drug use (teratogens) can cause damage to growing cells. These teratogens include:
    1. Some prescribed medications
    2. Maternal undernutrition
    3. Maternal smoking

2.Sensory Experiences of the Fetus:

1. The fetus can hear sounds, such as music, and recognizes them after birth.

3.Influence on Long-Term Health:

1. The experience of the fetus during prenatal life can influence the health of the newborn.
2. Prenatal experiences also affect the susceptibility to diseases that may occur later in life, during adulthood.

4.Importance of Early Prenatal Care:

1. Early prenatal care is essential for an optimal outcome of the pregnancy.

Cell division and gametogenesis:

1.Cell Division and the Nucleus:

The division of a cell begins in its nucleus, which contains gene-bearing chromosomes.

2.Types of Cell Division:

There are two main types of cell division: **mitosis** and **meiosis**.

1. **Mitosis**:
   Mitosis is a continuous process by which the body grows, develops, and replaces dead body cells. In mitosis, each daughter cell ends up with the same number of chromosomes as the parent cell, ensuring genetic consistency.
   1. The 46 chromosomes in a body cell are referred to as the **diploid number** of chromosomes.

3.Gametogenesis:

Gametogenesis refers to the production of gametes (sperm and ova). It involves specialized types of cell division:

1. **Spermatogenesis**: The process of mitosis that produces sperm in males.
2. **Oogenesis**: The process of mitosis that produces ova (egg cells) in females.

Would you like further clarification on any of these concepts?

Meiosis and gametogenesis:

1.Meiosis Overview:

Meiosis is a special type of cell division in which reproductive cells (sperm and ova) undergo two sequential divisions.

2.Reduction of Chromosomes:

During meiosis, the number of chromosomes in each resulting cell is reduced by half. This results in cells with **23 chromosomes**, each containing only one sex chromosome. This is referred to as the **haploid number** of chromosomes.

3.Completion of Meiosis:

1. In males, meiosis occurs during **spermatogenesis**, producing sperm.
2. In females, meiosis occurs during **oogenesis**, producing the ovum (egg cell).

4.Fertilization:

At the moment of fertilization, the sperm (with 23 chromosomes) and the ovum (with 23 chromosomes) unite. This restores the diploid number of chromosomes, resulting in a new cell with 46 chromosomes (23 from the sperm and 23 from the ovum).

5.Inheritance of Traits:

Traits are inherited from both the **mother** and the **father** because both contribute equally to the genetic makeup of the offspring.

6.Gametogenesis:

The formation of gametes (sperm and ova) through meiosis is called **gametogenesis**.

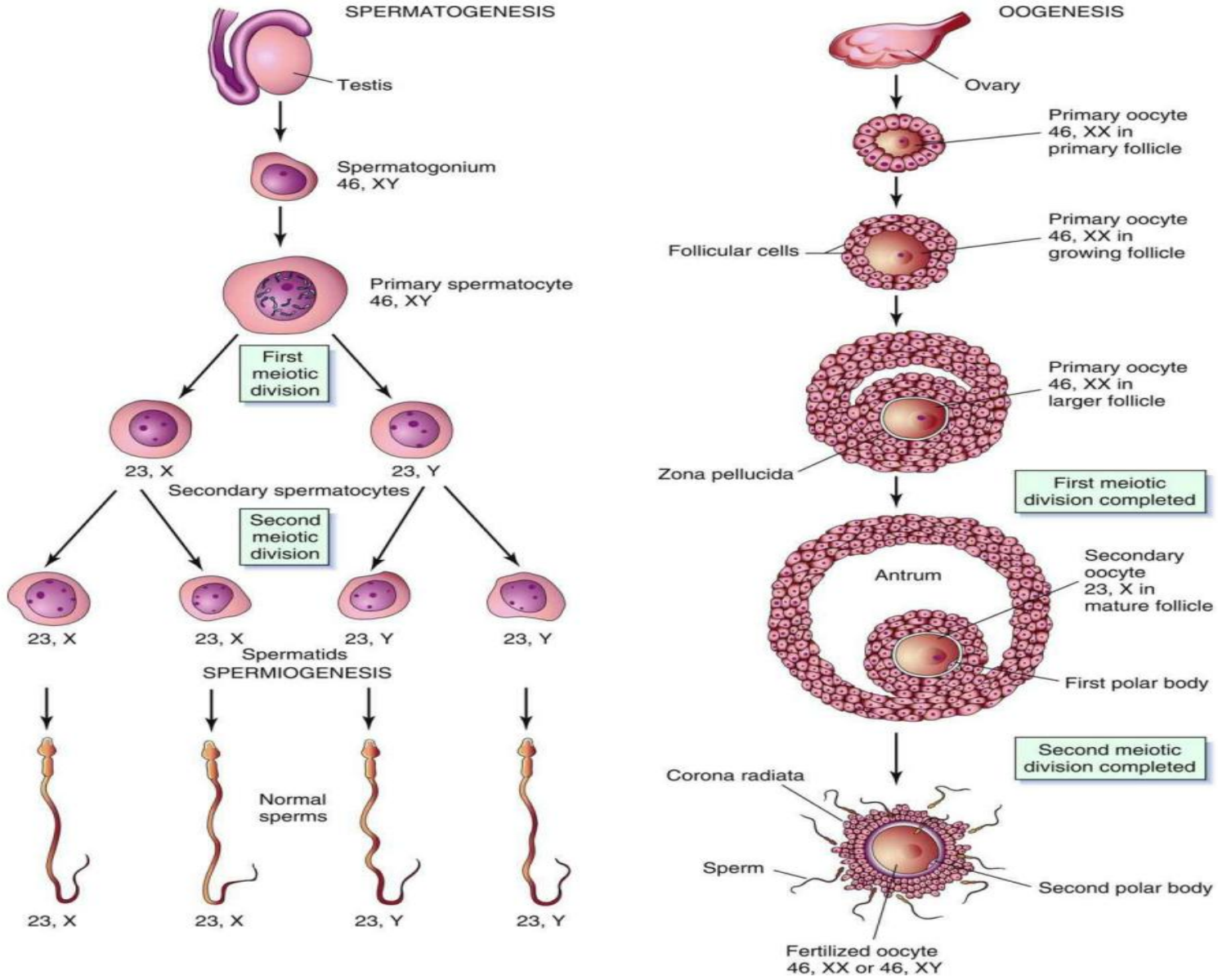


FIG. 3.1 Normal gametogenesis. Four sperm develop from one spermatocyte, each with 23 chromosomes—including one sex chromosome, either an X or a Y. In oogenesis, one ovum develops with 23 chromosomes—including one sex chromosome, always an X. An XY combination produces a boy, and an XX combination produces a girl. (From Moore KL, Persaud TVN, Torchia MG: *The developing human:*

explanation of fertilization:

1.Fertilization Process:

Fertilization occurs when a **sperm** penetrates an **ovum** (egg) and unites with it, restoring the total number of chromosomes to **46** (23 chromosomes from the sperm and 23 from the ovum).

2.Location of Fertilization:

Fertilization typically takes place in the **outer third of the fallopian tube**, near the ovary.

3.Sperm Journey:

After coitus (sexual intercourse), sperm pass through the **cervix** and **uterus** and travel into the **fallopian tubes**. The sperm move toward the egg using the **flagellar** (whiplike) movement of their tails. Sperm can reach the fallopian tubes within **5 minutes** after ejaculation.

4.Prevention of Multiple Fertilizations:

Once fertilization occurs, a **chemical change** in the membrane around the fertilized ovum prevents penetration by additional sperm. This ensures that only one sperm fertilizes the egg.

Would you like further details or clarifications on any part of this process?

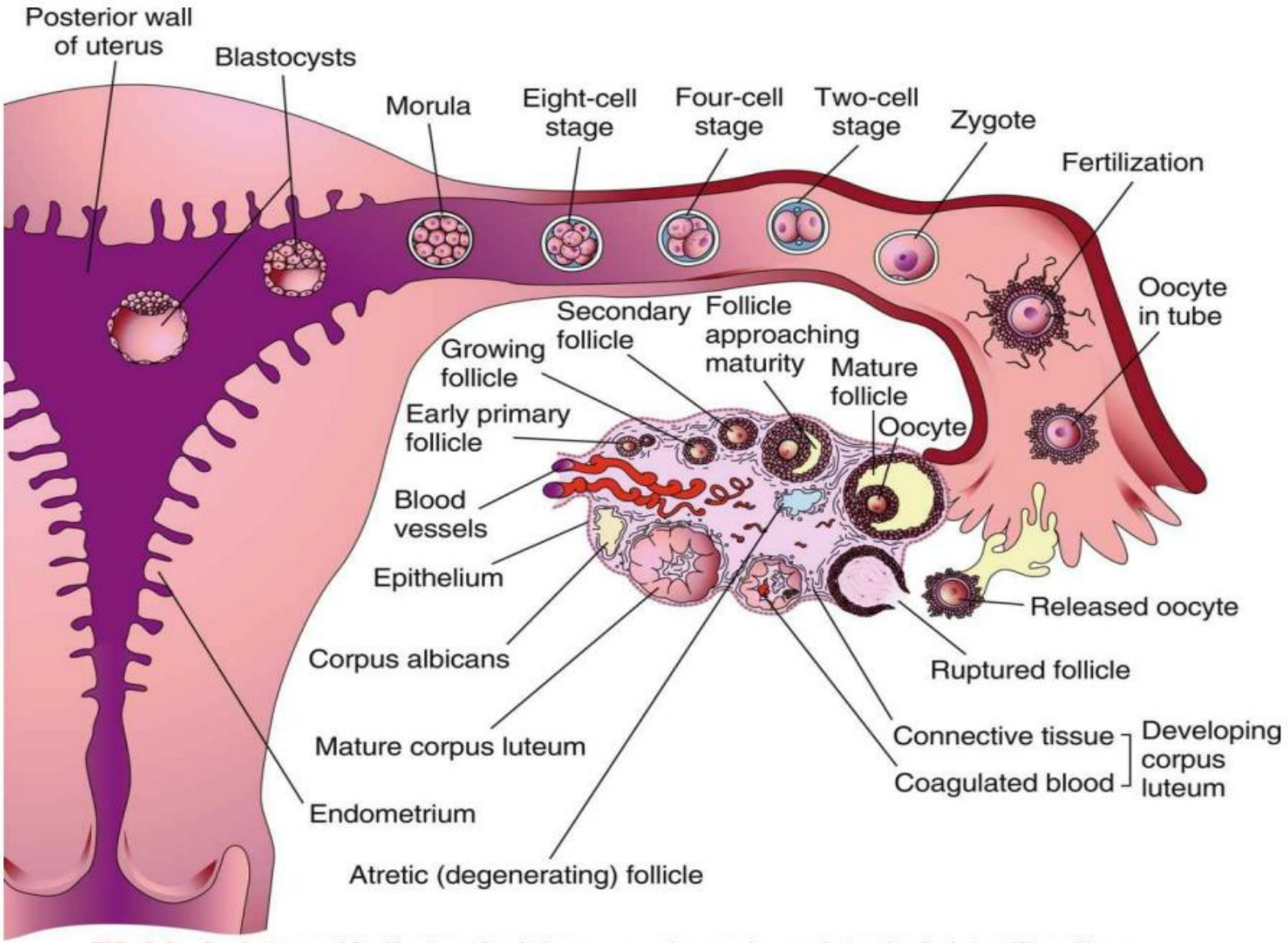


FIG. 3.2 Ovulation and fertilization. Ovulation occurs; the egg is caught by the fimbriae (fingerlike projections of the fallopian tube) and is guided into the fallopian tube where fertilization occurs. The zygote continues to multiply (but not grow in size) as it passes through the fallopian tube and implants into the posterior wall of the uterus. (From Moore KL, Persaud TVN, Torchia MG: *The developing human: clinically*

timing of fertilization and the **nursing tip**:

1.Survival Time of Gametes:

1. The **ovum** (egg) survives for **up to 24 hours** after ovulation, which is the brief window of time during which fertilization can occur.
2. The **sperm** can remain capable of fertilizing the ovum for **up to 5 days** after being ejaculated into the cervix.

2.Nursing Tip:

During **sexual counseling**, it is important for the nurse to emphasize the following:

1. The survival time of sperm can be as long as **5 days** after ejaculation into the cervix.
2. **Pregnancy can occur if intercourse happens up to 5 days before ovulation**, as the sperm can still fertilize the ovum during the window when it is viable.

sex determination:

1.Sex Determination at Fertilization:

The sex of a human offspring is determined at the moment of **fertilization**.

2.Contributions of the Gametes:

1. The **ovum** (egg) always contributes an **X chromosome**.
2. The **sperm** can contribute either an **X chromosome** or a **Y chromosome**.

3.Outcome Based on Sperm Chromosome:

1. If the sperm carrying the **X chromosome** fertilizes the **X-bearing ovum**, the offspring will be **female** (XX).
2. If the sperm carrying the **Y chromosome** fertilizes the ovum, the offspring will be **male** (XY).

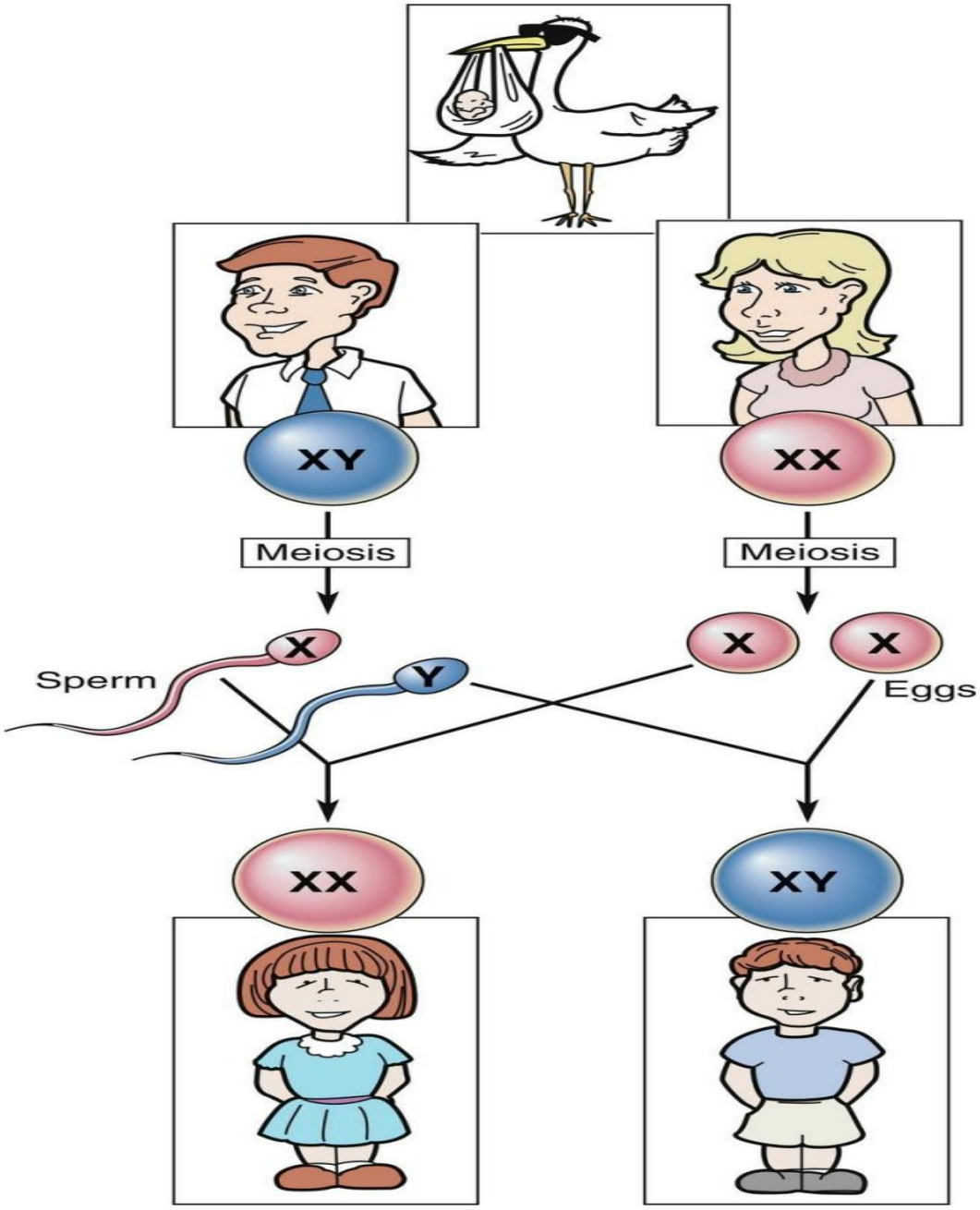

XY
XX
Meiosis
Meiosis
X
Y
X
X
Sperm
Eggs
XX
XY

FIG. 3.3 Sex determination.
If an X chromosome from the man unites with an X chromosome from the woman, the offspring will be female (XX).
If a Y chromosome from the man unites with an X chromosome from the woman, the offspring will be male (XY).

explanation of how sperm, female physiology, and hormonal influences affect sex determination:

1.Role of the Male Partner:

Because sperm can carry either an **X chromosome** or a **Y chromosome**, the **male partner determines the sex** of the child.

2.Influence of Female Physiology:

1. The **pH of the female reproductive tract** and **estrogen levels** in the woman's body can affect the survival and movement of **X-bearing** and **Y-bearing sperm**.
2. These factors influence which type of sperm (X or Y) is more likely to reach and fertilize the mature ovum. Thus, **female physiology** can play a role in determining which sperm fertilizes the egg.

3.Embryonic Development:

1. By **6 to 7 weeks of gestation**, the **male embryo** begins to differentiate under the influence of the **Y chromosome**, leading to the development of male characteristics.
2. By **8 weeks of gestation**, the male embryo begins secreting **testosterone**, which is crucial for the development of male genitalia.

4.Female Gonadal Development:

1. In the absence of testosterone and in the presence of **estrogen**, the **female gonads** (ovaries) develop. This process occurs if the embryo has two **X chromosomes**.

the **nursing tips** related to **sex determination Nursing Tips:**

1.Influence of Both Parents on Sex Determination:

Both the **mother** and **father** influence the sex of their offspring, although it is the **father** who contributes the actual **sex chromosome** (X or Y).

2.Cultural Impact of Sex Determination:

Understanding that both parents contribute to the sex of the child may help reduce **blame** in certain cultures when the child is not the **desired sex**.

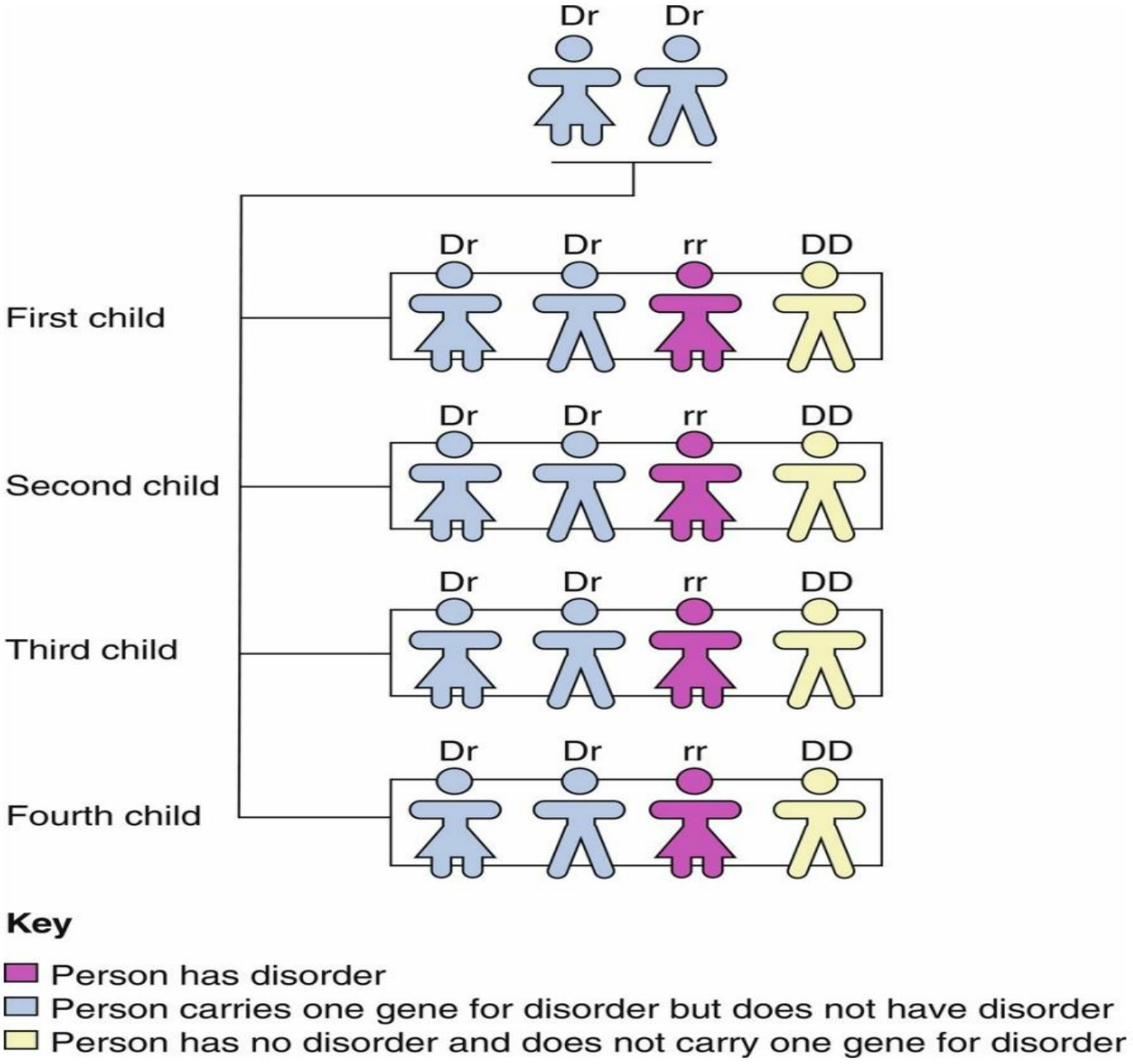


FIG. 3.4 Inheritance. This figure shows how a disorder carried as a recessive trait can be passed along to an offspring when each parent is a carrier of that recessive trait. *D* represents a dominant gene; *r* represents a recessive gene.

inheritance, genetic disorders, and **nursing tips**:

Nursing Tips:

1. **Reproductive Decision Making**:
   Knowledge of **inheritance** allows the nurse to provide helpful information to prospective parents regarding their genetic risks and reproductive options. Nurses can also suggest **referrals** for genetic counseling if needed, supporting informed decision-making.
2. **Inheritance and Genetic Disorders:**
3. **Gene Pairing**:
   Most **genes** are paired, with one gene coming from the **mother** and the other from the **father**. Only one gene from each pair is passed on to the fertilized egg.
4. **Recessive vs. Dominant Disorders**:
5. **Chance of Developing a Disorder**:
6. **Genetic Testing**:
   Genetic testing can play a crucial role in:
   1. **Diagnosing disorders**.
   2. **Predicting the risk of future disorders** in offspring.
   3. **Assisting in reproductive decisions** by informing parents about the likelihood of passing on genetic disorders.

tubal transport of the zygote:

1. Formation of the Zygote:

•The **zygote** is the cell formed when a **sperm** and **ovum** unite.

•After fertilization, the zygote is transported through the **fallopian tube** and into the **uterus**.

2. Fertilization and Transport:

•Fertilization typically occurs in the **outer third of the fallopian tube**.

•After fertilization, the zygote undergoes **rapid mitotic division** (cleavage) as it is transported through the fallopian tube toward the uterus.

3. Cleavage and Division:

•The process of cleavage begins with the zygote dividing into **two cells**, then **four cells**, then **eight cells**, forming the **blastomere**.

•As the zygote divides, the **individual cells** become smaller, but the overall size of the zygote does not increase.

•Eventually, the zygote forms a **solid ball of cells** called the **morula**.

4. Entering the Uterus:

•The **morula** enters the uterus on the **third day** after fertilization and **floats** there for an additional **2 to 4 days**.

5. Formation of the Blastocyst:

•As the morula continues to develop, the cells form a **cavity**, and two distinct layers begin to evolve:

- The **inner layer** of cells forms a solid mass called the **blastocyst**, which will develop into the **embryo** and the **embryonic membranes**.
- The **outer layer** of cells is called the **trophoblast**, and it will develop into an embryonic membrane known as the **chorion**.

6. Ectopic Pregnancy:

•Occasionally, the zygote does not move through the fallopian tube properly and instead becomes **implanted in the lining of the fallopian tube**, resulting in an **ectopic pregnancy** (also called **tubal pregnancy**), which is a medical emergency.

This process marks the early stages of pregnancy, and understanding it helps explain the development and early implantation of the embryo.

the **implantation of the zygote**:

1. Location of Implantation:

•The **zygote** typically implants in the **upper section of the posterior uterine wall**.

2. Process of Implantation:

•Once the **blastocyst** (the developing zygote) reaches the uterus, it begins to **burrow into the prepared lining** of the uterus, called the **endometrium**.

3. Transformation of the Endometrium:

•The endometrium undergoes changes and becomes known as the **decidua** during implantation.

•The area directly under the blastocyst, where implantation occurs, is called the **decidua basalis**.

4. Formation of the Placenta:

•The **decidua basalis** gives rise to the **maternal part of the placenta**, which will play a crucial role in nutrient and waste exchange between the mother and the developing fetus.

Implantation is a key step in establishing pregnancy, as it enables the embryo to receive nutrients from the mother and continue developing.

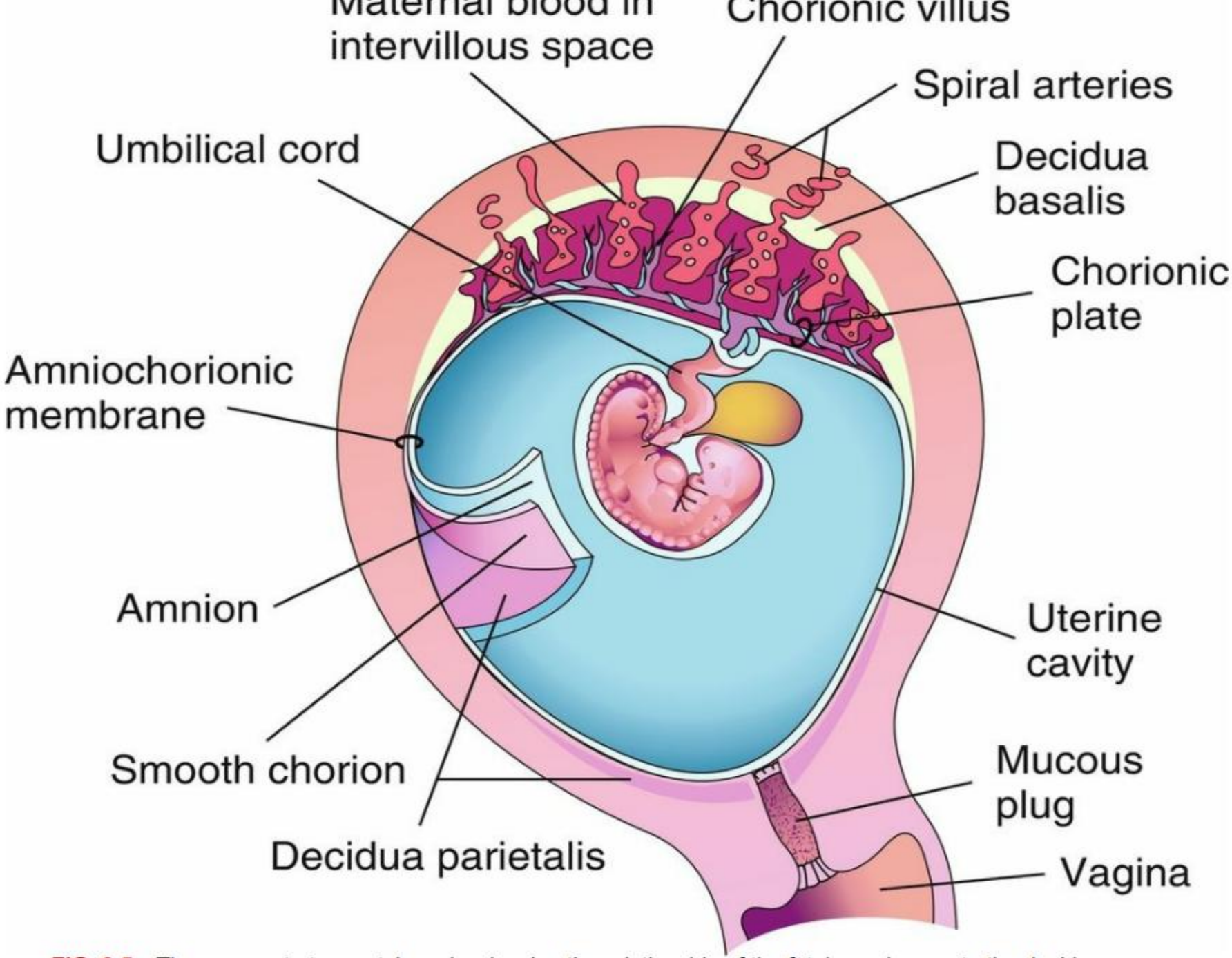


FIG. 3.5 The pregnant uterus at 4 weeks showing the relationship of the fetal membranes to the decidua of the uterus and the embryo. (From Moore KL, Persaud TVN, Torchia MG: *The developing human:*

cell differentiation and development:

1. Stage Between Fertilization and Implantation:

•During the **week** between **fertilization** and **implantation**, the cells within the zygote are **identical** to each other.

2. Cell Differentiation After Implantation:

•After implantation, the cells begin to **differentiate**, meaning they start to take on **specialized functions** and form various structures.

3. Appearance of Key Structures:

•The following structures appear as part of this differentiation process:

- **Chorion, Amnion, Yolk sac**
- **Primary germ layers** (which later develop into all the body's organs and tissues)

4. Chorion Development:

•The **chorion** develops from the **trophoblast**, which is the outer layer of embryonic cells.

•It **envelops** the **amnion**, **embryo**, and **yolk sac**, forming an important protective layer.

5. Chorion Structure:

•The chorion is a **thick membrane** with **fingerlike projections** called **villi** on its outermost surface.

•The villi immediately beneath the embryo extend into the **decidua basalis** (the part of the uterine lining beneath the embryo).

6. Formation of the Placenta:

•The villi in the decidua basalis form the **embryonic or fetal portion of the placenta**, which is crucial for nutrient and gas exchange between the mother and the developing fetus.

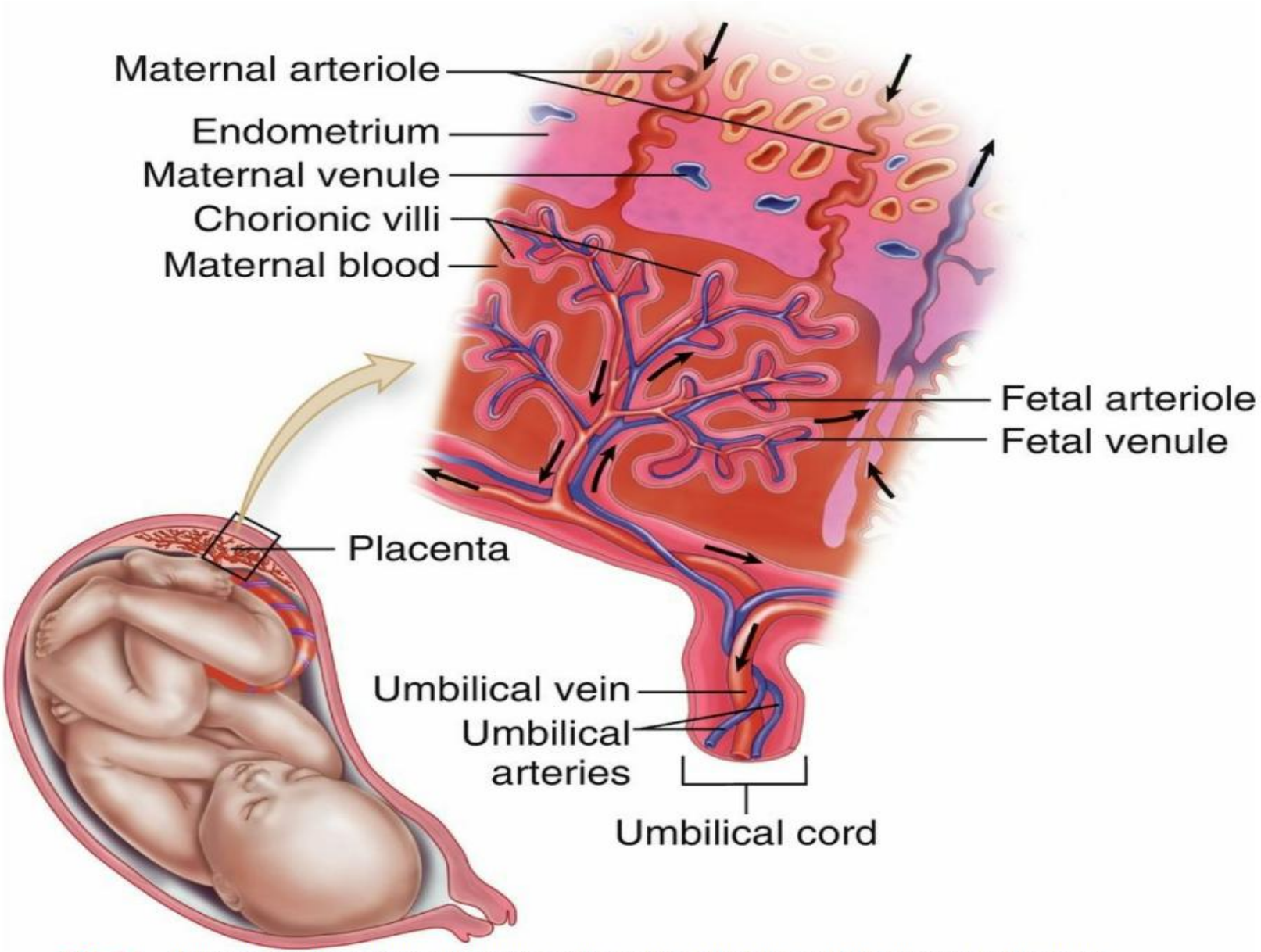


FIG. 3.6 Maternal–fetal circulation showing the relationship of the fetus and the placenta in the uterus. Close placement of the fetal blood supply to the maternal blood in the placenta is shown. The maternal blood in the lacuna permits the diffusion of nutrients and other substances; some harmful substances are prevented from passing through by a thin placental barrier. No mixing of fetal or maternal blood occurs. (From Patton KT, Thibodeau GA: *Anatomy & physiology,* ed 9, St. Louis, 2016, Mosby.)

the **amnion** and its functions:

1. Structure of the Amnion:

•The **amnion** is the **second membrane** that surrounds and **protects** the developing embryo.

•It forms the boundaries of the **amniotic cavity**, and its **outer aspect** meets the **inner aspect** of the **chorion**.

2. Amniotic Sac:

•Together, the **chorion** and the **amnion** form the **amniotic sac**, also known as the **bag of waters**.

•The amniotic sac is filled with **amniotic fluid**, which allows the embryo to **float freely** within it.

3. Amniotic Fluid:

•**Amniotic fluid** is typically **clear**, has a mild odor, and may contain **vernix** (a protective skin covering) and **lanugo** (fine hair on the fetal skin).

•The volume of amniotic fluid steadily increases from about **30 mL at 10 weeks** gestation to **350 mL at 20 weeks**.

•By **37 weeks**, the volume of amniotic fluid is about **1000 mL**.

4. Fetal Interaction with Amniotic Fluid:

•In the latter part of pregnancy, the fetus may **swallow up to 400 mL of amniotic fluid per day**.

•The fetus also **excretes urine** into the amniotic fluid, which helps maintain the volume and composition of the fluid.

5. Functions of Amniotic Fluid:

- **Maintains an even temperature**: The amniotic fluid helps regulate the temperature around the fetus, providing a stable environment.
- **Prevents adherence to the fetal skin**: The fluid prevents the amniotic sac from sticking to the fetal skin, ensuring normal development.
- **Allows symmetrical growth**: The amniotic fluid supports the fetus's growth by allowing unrestricted movement and expansion.
- **Provides buoyancy and fetal movement**: The fluid allows the fetus to float and move freely within the sac, promoting muscle development.
- **Acts as a cushion**: Amniotic fluid serves as a protective cushion, safeguarding the fetus and the **umbilical cord** from injury.

The amniotic fluid and sac play vital roles in protecting, nurturing, and supporting the fetus as it develops throughout pregnancy.

the **yolk sac** and the **germ layers**:

1. Yolk Sac:

•On the **ninth day** after fertilization, a cavity called the **yolk sac** forms within the **blastocyst**.

•The **yolk sac** functions primarily during **embryonic life** and plays a crucial role in the early development of the embryo.

2. Functions of the Yolk Sac:

•The yolk sac is responsible for **initiating the production of red blood cells**, which is essential for oxygen transport during the early stages of embryonic development.

•This function continues for about **6 weeks**, after which the **embryonic liver** takes over the production of red blood cells.

•As the **umbilical cord** develops, it encompasses the yolk sac, and eventually, the yolk sac **degenerates**.

3. Germ Layers:

•After implantation, the **zygote** in the **blastocyst stage** undergoes a transformation, and the **embryonic disc** develops into **three primary germ layers**:

- **Ectoderm**
- **Mesoderm**
- **Endoderm**

4. Development from Germ Layers:

•Each of the three **germ layers** gives rise to different parts of the growing embryo:

- The **ectoderm** forms structures like the skin, hair, and nervous system.
- The **mesoderm** forms muscles, bones, the circulatory system, and other connective tissues.
- The **endoderm** forms internal structures like the digestive system, liver, and lungs.

Box 3.1

Body Parts That Develop From the Primary Germ Layers

Ectoderm

Outer layer of skin
Oil glands and hair follicles of skin
Nails and hair
External sense organs
Mucous membrane of mouth and anus

Mesoderm

True skin
Skeleton
Bone and cartilage
Connective tissue
Muscles
Blood and blood vessels
Kidneys and gonads

Endoderm

Lining of trachea, pharynx, and bronchi
Lining of digestive tract

Lining of bladder and urethra

the **prenatal developmental milestones** during intrauterine development:

Three Basic Stages of Prenatal Development:

1.Zygote Stage:

1. After **fertilization**, the zygote begins to grow and divide as it travels through the **fallopian tube** toward the uterus.
2. Once it reaches the uterus, the zygote **implants** into the **uterine wall** and continues to develop.

2.Embryonic Stage (2 to 8 Weeks):

1. This period, from **2 to 8 weeks** after fertilization, is known as the **embryonic stage**. During this time, the developing organism is called an **embryo**.
2. The **embryo** undergoes rapid development, and all major organ systems begin to form.
3. By the second week after fertilization, the **ectoderm**, **endoderm**, and **amnion** begin to develop, laying the foundation for the body's tissues and organs.

3.Fetal Stage (9 Weeks to Birth):

1. From the **ninth week** of development until birth, the developing infant is called a **fetus**.
2. During the fetal stage, the organs and systems that began to form during the embryonic stage continue to mature and grow.
3. The fetus gains weight, and features such as **hair**, **fingernails**, and **eyelashes** begin to form.

Development of the Germ Layers:

•By the **second week after fertilization**, the **germ layers** (**ectoderm**, **endoderm**, and **mesoderm**) begin to develop, forming the foundation of the embryo's organs and tissues.

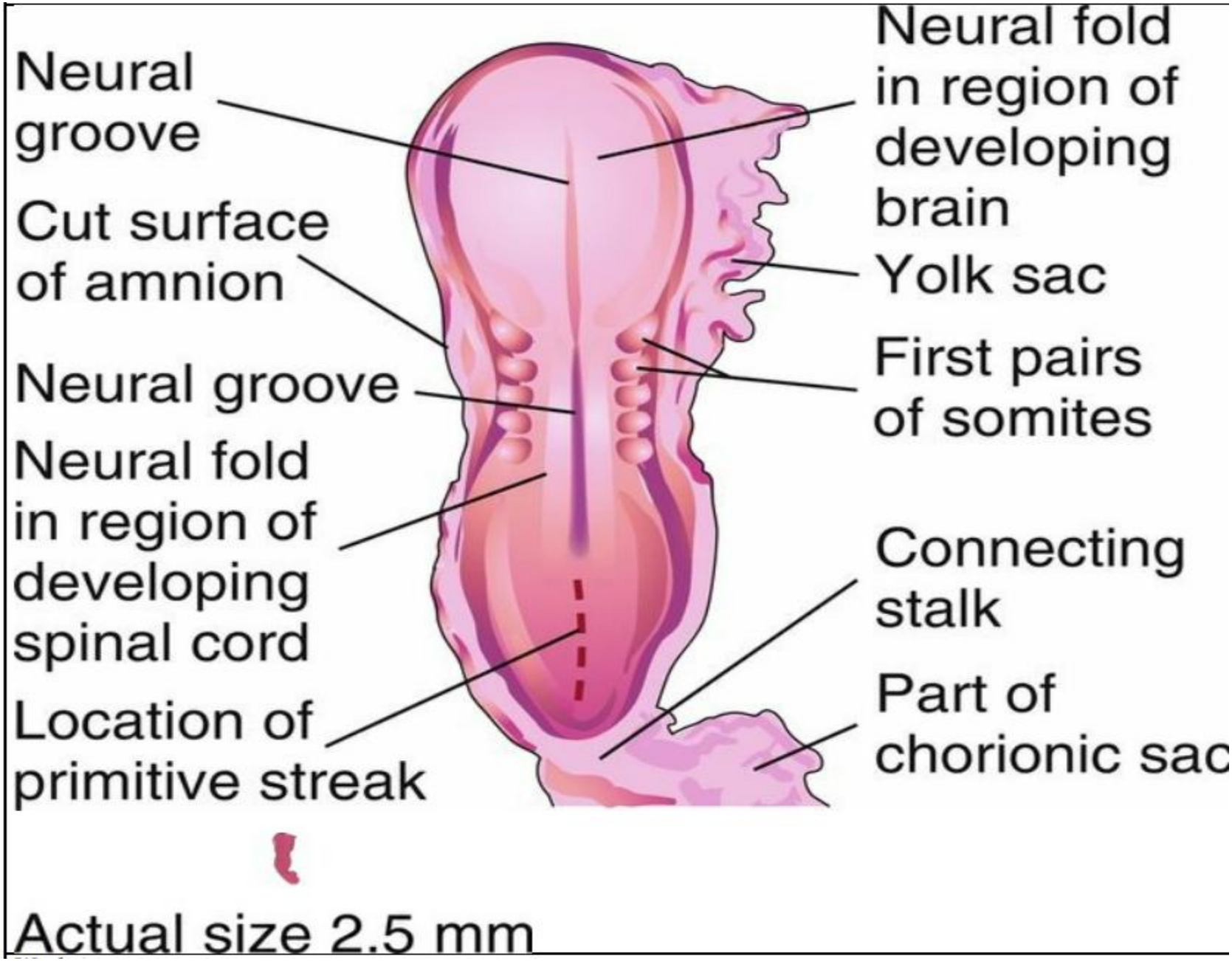
•These layers give rise to all the different structures in the body:

- The **ectoderm** forms structures like the skin and nervous system.
- The **endoderm** gives rise to the digestive and respiratory systems.
- The **mesoderm** develops into muscles, bones, and the circulatory system.

These stages represent critical milestones in prenatal development as the zygote evolves into a fully developed fetus ready for birth.

Embryonic and Fetal Development:

- **Week 3:**
  - **Length:** 1.5–2.5 mm
  - **Weight:** Not specified
  - **Development:**
    - **Cardiovascular:** Single tubular heart is formed.
    - **Nervous:** Neural tube forms; primitive spinal cord and brain appear.
- **Week 4:**
  - **Length:** 3.5–4 mm
  - **Weight:** Not specified
  - **Development:**
    - **GI:** Esophagus and trachea separate; stomach forms.
    - **Nervous:** Neural tube closes; forebrain forms.
    - **Musculoskeletal:** Upper and lower limb buds appear.
    - **Senses:** Eyes begin to form.
- **Week 6:**
  - **Length:** 11–13 mm
  - **Weight:** Not specified
  - **Development:**
    - **Senses:** Auditory canal forms; eyes are clearly visible.
    - **Cardiovascular:** Heart has all four chambers.
    - **GI:** Nasal cavity and upper jaw form.


Neural groove
Cut surface of amnion
Neural groove
Neural fold in region of developing spinal cord
Location of primitive streak
Neural fold in region of developing brain
Yolk sac
First pairs of somites
Connecting stalk
Part of chorionic sac
Actual size 2.5 mm

Week 4 of prenatal development:

Week 4 Milestones:

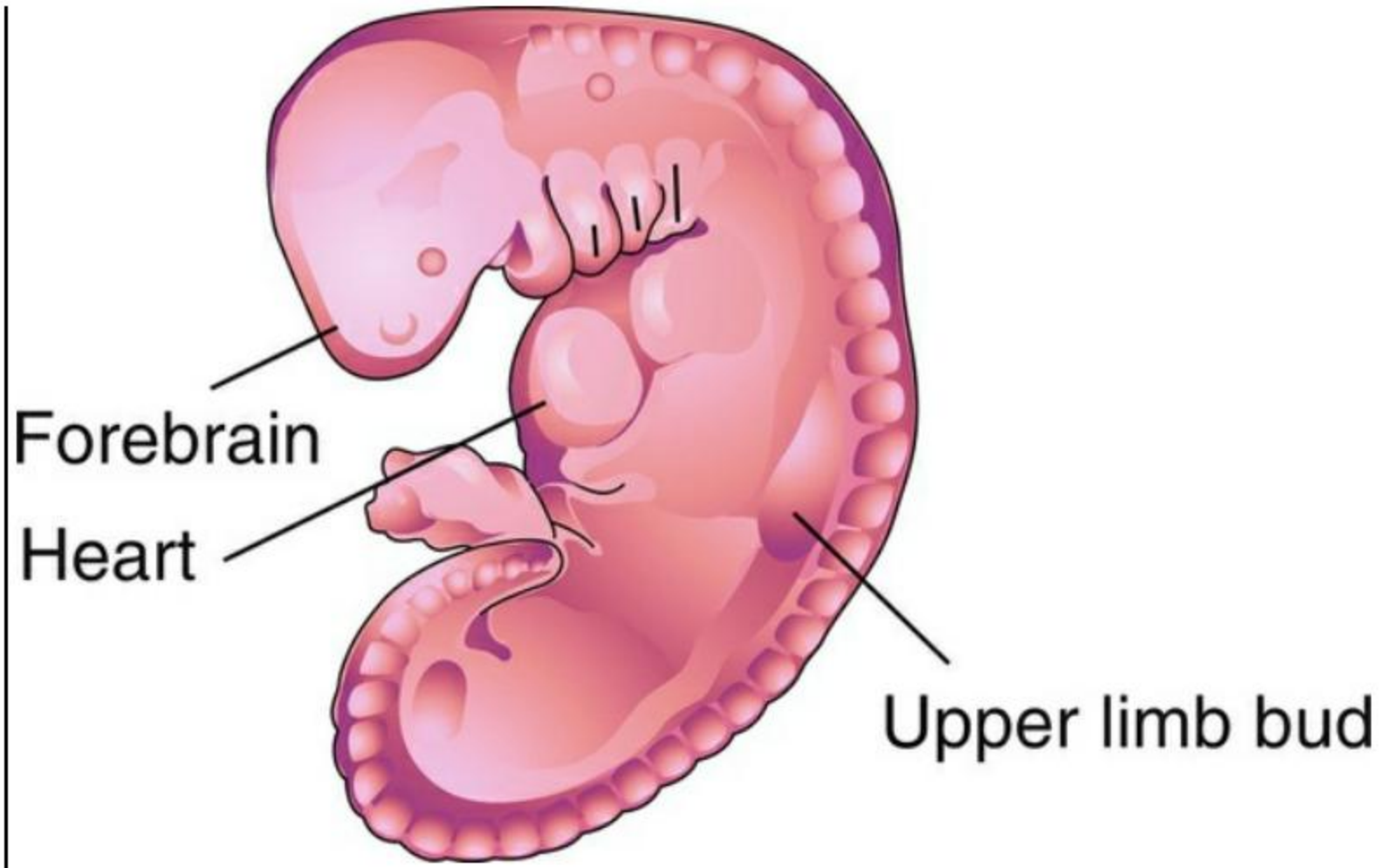
•**Size**: The developing embryo is approximately **3.5–4 mm** in length.

Key Developmental Changes:

1.Gastrointestinal (GI) Development:

1. The **esophagus** and **trachea** begin to **separate** from each other, marking the start of the development of distinct pathways for digestion (esophagus) and respiration (trachea).
2. The **stomach** starts to **form** as part of the early digestive system, setting the foundation for future development of the entire gastrointestinal tract.

During this time, critical developments continue as the embryo's major organ systems begin to form and differentiate. The GI system’s development is essential for later fetal nutrition and health.


Forebrain
Heart
Upper limb bud

Week 6 of prenatal development:

Week 6 Milestones:

•**Size**: The developing embryo is approximately **11–13 mm** in length.

Key Developmental Changes:

1.Senses:

1. The **auditory canal** begins to form, which is essential for hearing development.
2. The **eye** becomes more **obvious**, with the formation of the basic structures of the eye, although it is not yet fully developed.

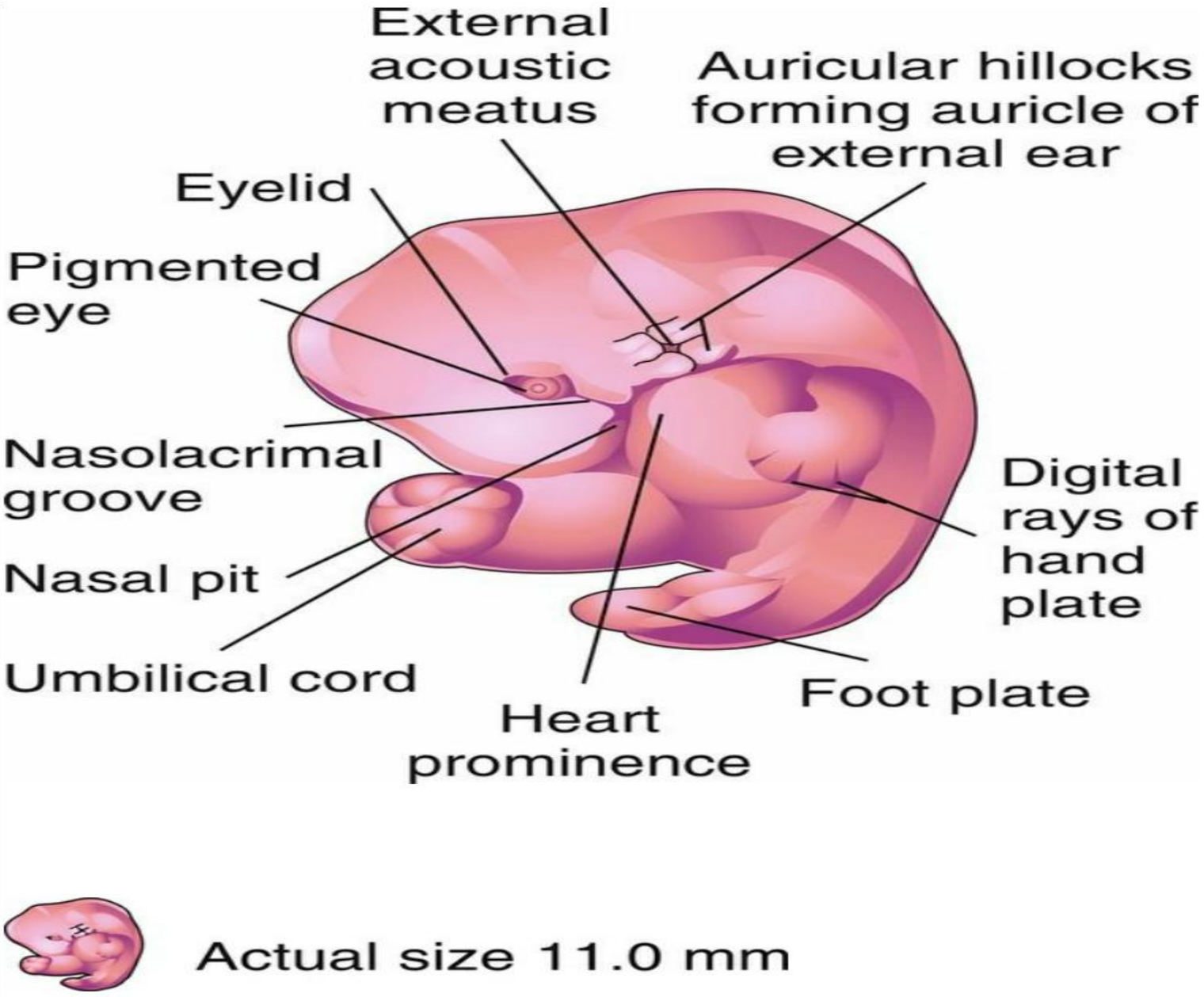
2.Cardiovascular System:

1. The **heart** is now fully formed with all **four chambers**. This is a significant milestone as it ensures the heart can effectively pump blood throughout the developing body.

3.Gastrointestinal (GI) System:

1. The **nasal cavity** and the **upper part of the gastrointestinal tract** begin to form, contributing to the development of the respiratory and digestive systems.

During this stage, the embryo is undergoing critical developments that are essential for sensory, circulatory, and digestive functions.


External acoustic meatus
Auricular hillocks forming auricle of external ear
Eyelid
Pigmented eye
Nasolacrimal groove
Digital rays of hand plate
Nasal pit
Umbilical cord
Foot plate
Heart prominence
Actual size 11.0 mm

Week 8 of prenatal development:

•**Size**: The developing embryo is approximately **30 mm** in **crown-rump length** and weighs about **6 grams**.

1.Appearance:

1. The embryo now has a **distinct human appearance**. The facial features become more recognizable, and the overall shape is more human-like.

2.Movement:

1. **Purposeful movements** begin to occur, as the embryo's muscles and nervous system develop further, allowing it to move intentionally, though these movements are still small and not yet felt by the mother.

3.Tail: The **tail**, which was present in earlier stages, has **disappeared** by this point in development.

4.Sex Organs:

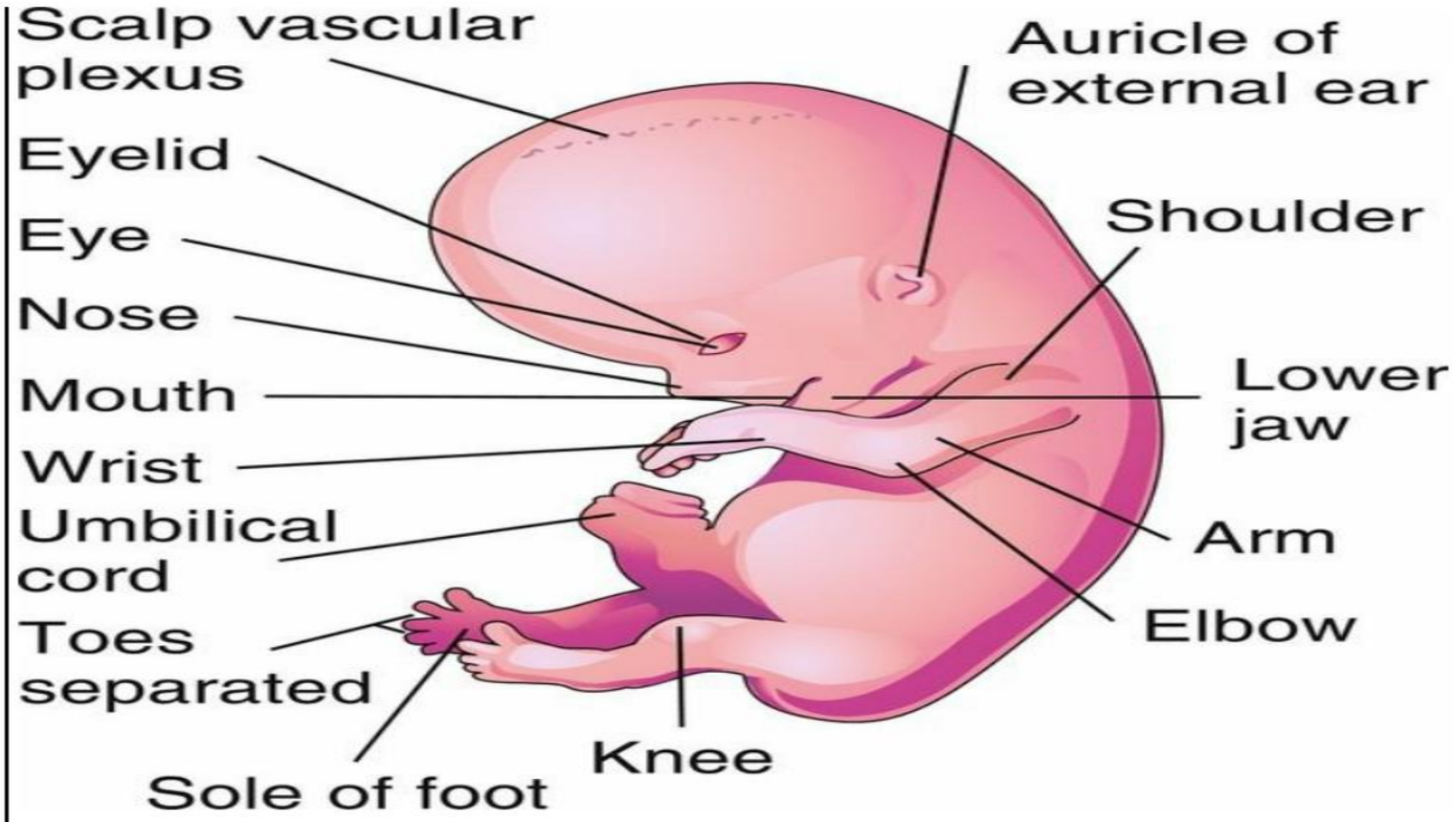
1. The **sex organs** begin to form, although they may not yet be fully distinguishable as male or female externally at this point.

5.Formation of Structures:

1. The **beginnings of most external and internal structures** (such as the limbs, face, and internal organs) are formed, though they will continue to develop and refine over the coming weeks.

6.Transition to Fetal Period:

1. The embryo officially enters the **fetal period** at the end of week 8. From now until birth, the organism is considered a **fetus** and will undergo significant growth and maturation of its organs and systems.



Actual size 30.0 mm

Week 17 of prenatal development:

•**Size**: The developing fetus is approximately **50 mm** in **crown-rump length** and weighs about **260 grams**.

1.Movement:

1. The **genitalia** and **leg movements** can now be seen on ultrasound, and the **mother may begin to feel** these movements, commonly referred to as **quickening**.

2.Bone Development:

1. The fetus's **bones** are **ossified** (hardened), meaning they begin to transform from cartilage into bone, preparing for further growth and development.

3.Eye Movements:

1. The **eyes** begin to show **movement**. While the eyelids are still closed, the fetus can move its eyes in response to stimuli.

4.Sucking and Swallowing:

1. The fetus can **suck and swallow amniotic fluid**, a crucial developmental process that helps in the maturation of the digestive system and facilitates fetal growth.

5.Ovarian Development:

1. The **ovaries** contain **ova** (eggs) in female fetuses. This marks the beginning of the development of the reproductive system.

6.Skin Development:

1. The fetus's **skin** is still very **thin**, allowing the **blood vessels in the scalp** to be visible through the skin.

7.Fat and Skin:

1. There is **no subcutaneous fat** present at this stage, meaning the fetus's skin is still quite delicate. The absence of fat makes the fetus appear more translucent.

Week 25 Milestones:

•**Size**: The developing fetus is approximately **28 cm** (**11.2 inches**) in **crown-heel length** and weighs about **780 grams** (**1 lb 10 oz**).

Key Developmental Changes:

1.Skin Development:

1. The fetus's skin is still **wrinkled** and **lean**, a result of the **lack of subcutaneous fat**. However, this will change in later weeks as fat accumulation begins.

2.Eye Development:

1. The **eyes are open**, and the fetus may begin to respond to light and other stimuli. The eye structures are more developed at this point.

3.Viability:

1. The fetus is now considered **viable**, meaning it has a chance of surviving outside the womb with medical support if born prematurely.

4.Mother's Perception of Movement:

1. The mother can feel **stronger movements** (quickening), and the fetus has a more predictable **schedule of sleeping and moving**.

5.Vernix Caseosa:

1. **Vernix caseosa**, a protective, waxy substance, is present on the skin. This helps to protect the skin from the amniotic fluid and facilitates smooth movement in the womb..

6-Lanugo:

1. **Lanugo**, fine, soft hair, covers the fetus's body, providing warmth and protection for the skin.

7- Brown Fat Formation:

1. **Brown fat** begins to form, which is important for thermoregulation (keeping the fetus warm after birth).

8- Lung Development:

1. The fetus's **lungs** begin to **secrete surfactant**, a substance that helps the lungs expand and function properly at birth, improving the fetus's chances of breathing outside the womb.

9- Fingernails:

1. **Fingernails** are now present, contributing to the development of the fingers.

10- Respiratory Movements:

1. The fetus begins to engage in **respiratory movements**, although the lungs are not yet fully capable of supporting independent breathing. These movements help the lungs mature

Week 26 of prenatal development:

•**Size**: The developing fetus is approximately **38 cm** (**15 inches**) in **crown-heel length** and weighs about **1260 grams** (**2 lb 10 oz**).

Key Developmental Changes:

1.Position:

1. The fetus assumes a **stable (cephalic) position** in the uterus, meaning the head is down and facing the cervix, which is the typical position for birth.

2.Central Nervous System:

1. The **central nervous system (CNS)** is now **functioning**, with the brain and spinal cord actively coordinating movements and responses to stimuli.

3.Skin Development:

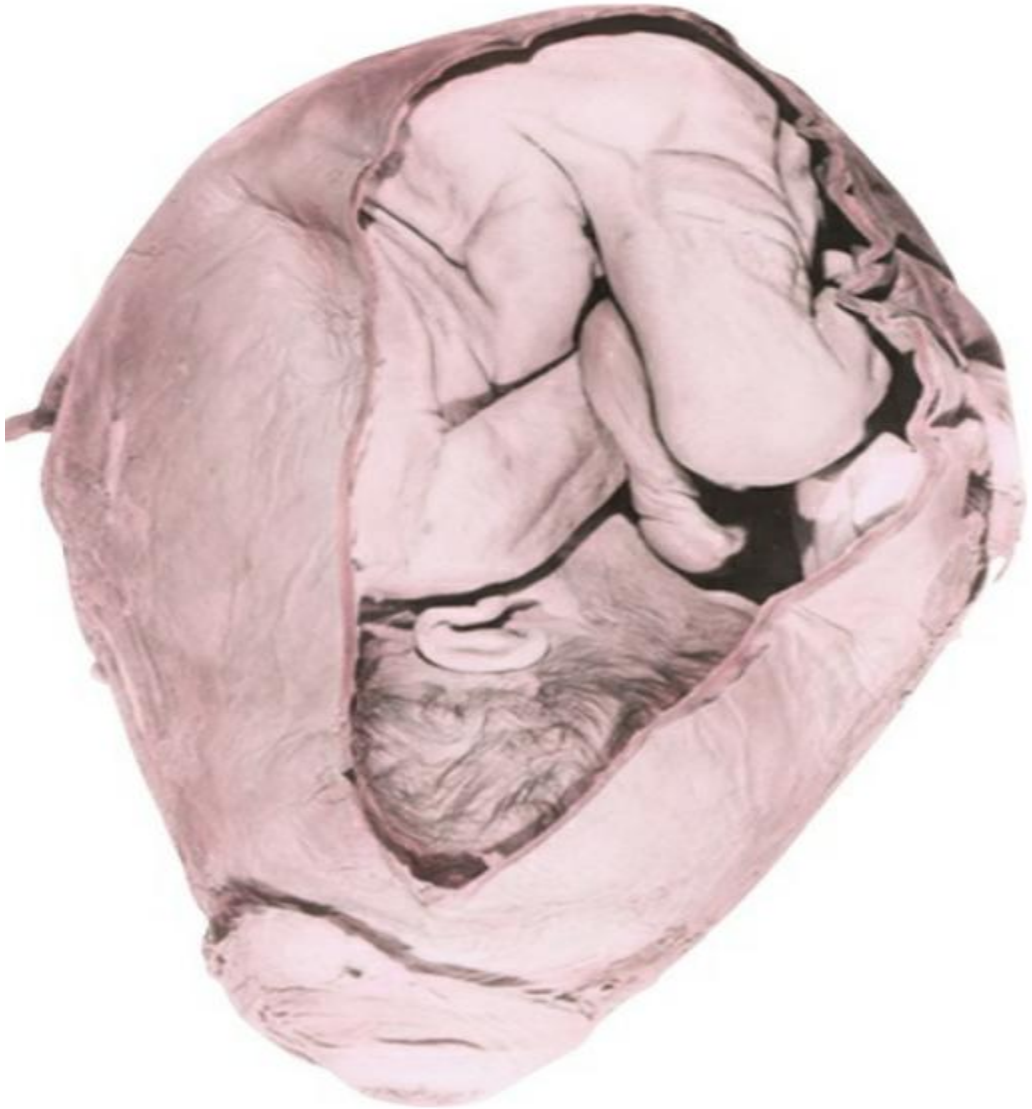
1. The fetus's skin is now **less wrinkled**, thanks to the presence of **subcutaneous fat** that is starting to accumulate under the skin, contributing to a smoother appearance.

4.Blood Cell Formation:

1. The **spleen** stops producing blood cells, and the **bone marrow** begins to take over the role of producing blood cells, which is essential for maintaining a healthy circulatory system.

5.Lung Development:

1. There is **increased surfactant** present in the lungs, which helps the lungs continue to mature in preparation for breathing after birth. Surfactant is critical for keeping the lungs' air sacs (alveoli) from collapsing. development during this stage?



Week 36 of prenatal development:

•**Size**: The developing fetus is approximately **48 cm** (**19 inches**) in **crown-heel length** and weighs about **2500 grams** (**5 lb 12 oz**).

Key Developmental Changes:

1.Fat Development:

1. **Subcutaneous fat** is now present, contributing to the fetus's increasing size and preparing for life outside the womb by helping to regulate body temperature after birth.

2.Skin Appearance:

1. The fetus's skin is now **pink and smooth**, having become less wrinkled due to the accumulation of fat beneath the skin.

3.Reflexes:

1. The **grasp reflex** is now present. This reflex allows the fetus to grasp objects placed in its hands, an important developmental milestone as it prepares for life outside the womb.

4.Head and Abdomen:

1. The **circumferences of the head and abdomen** are now approximately **equal**, which is characteristic of late fetal development. This indicates that the body is becoming more proportionate in preparation for birth.

5.Lung Development:

1. A **surge in lung surfactant production** occurs, which further prepares the lungs for independent breathing after birth. Surfactant is essential for keeping the alveoli (air sacs) in the lungs from collapsing and ensuring proper lung function.

NOTE: Full term is considered 39 to 40 weeks gestation. The crown–heel length is 48 to 52 cm (18 to 21 inches), and the weight is 3000 to 3600 g (6 lb 1 oz to 7 lb 15 oz). GI, Gastrointestinal.

39 to 40 Weeks Gestation (Full Term):

1. The fetus is considered full term.
2. Infant survival and development at birth depend on both the infant's biological development and the response of the parent(s).

1.Fetal Monitoring:

1. The status of the fetus can be monitored through ultrasound, fetal tests, and home monitoring of fetal movements (kick counts).

the nutrition considerations regarding folic acid and neural tube defects:

1.Folic Acid and Neural Tube Defects:

1. Folic acid supplements can **prevent most neural tube defects** (e.g., spina bifida).

2.Importance of Early Prenatal Care:

1. In an **unplanned pregnancy**, a neural tube defect may occur **before a woman knows she is pregnant**.

3.Timing of Folic Acid Intake:

1. It is essential to start **folic acid supplements early**, ideally before conception and in the first few weeks of pregnancy, to protect the embryo during its early development.

4.Nutrition and Embryo Protection:

1. Early **prenatal care** and **good nutrition** (including folic acid) are crucial for ensuring proper development and protection of the embryo in the very early stages of pregnancy.

Accessory Structures of Pregnancy:

•The **placenta**, **umbilical cord**, and **fetal circulation** support the fetus as it completes prenatal life and prepares for birth.

Placenta:

1.Function:

1. The placenta is a **temporary organ** that supports **fetal respiration**, **nutrition**, and **excretion**.
2. It also functions as an **endocrine gland**, producing hormones necessary for maintaining pregnancy and fetal development.

2.Formation:

1. The placenta forms when the **chorionic villi** of the embryo extend into the **blood-filled spaces** of the mother's **decidua basalis**.

3.Maternal Side:

1. The maternal side of the placenta arises from the **decidua basalis** and has a **beefy, red appearance**.

4.Fetal Side:

1. The fetal side of the placenta develops from the **chorionic villi** and **chorionic blood vessels**.
2. The **amnion** covers the fetal side, including the **umbilical cord**, and gives it a **grayish, shiny appearance** at term.

1.Placenta Size and Health Indicators:

1. **Enlarged placenta** may signal **maternal diabetes mellitus** and could indicate **increased morbidity** for the fetus in the **neonatal period** or later in life.
2. **Small placenta** can result from factors like **stress**, **undernutrition**, **exposure to steroids** during pregnancy, or **chronic hypoxia** (low oxygen levels).

2.Role in Fetal Development:

The placenta plays an **important role in fetal development** and has **clinical impacts** that extend beyond 9 months of gestation. **Placental Transfer:**

1.Blood Supply Separation:

1. A **thin membrane** separates the maternal and fetal blood supplies, and **the two blood supplies do not normally mix**.

2.Fetal Blood in Maternal Circulation:

1. **Separation of the placenta at birth** can allow some fetal blood to enter the maternal circulation, which may cause **problems in subsequent pregnancies** if there is **blood type incompatibility** (e.g., Rh incompatibility).

3.Fetal Deoxygenated Blood and Waste Removal:

1. **Fetal deoxygenated blood** and **waste products** leave the fetus through the **two umbilical arteries**.
2. They enter the placenta through the **branch of a main stem villus**, which extends into the **intervillous space (lacuna)**.

4-Maternal Blood Flow:

1. **Oxygenated, nutrient-rich blood** from the mother **spurts into the intervillous space** from the **spiral arteries** in the decidua.

5-Gas and Nutrient Exchange:

1. The fetal blood releases **carbon dioxide** and waste products, and takes in **oxygen** and **nutrients** from the maternal blood before returning to the fetus through the **umbilical vein**.

6-Placental Membrane and Protection:

1. The **thin placental membrane** provides **some protection** but is **not a barrier** to most substances ingested by the mother.

7-Transfer of Harmful Substances:

1. Many **harmful substances**, including **drugs** (therapeutic and recreational), **nicotine**, and **viral infectious agents**, can be transferred to the fetus.
2. These substances may cause **fetal drug addiction**, **congenital anomalies**, or **fetal infections**.

the **placental hormones** and their roles, with a focus on **progesterone**:

Placental Hormones:

The placenta produces **four hormones**:

1.Progesterone

2.Estrogen

3.Human Chorionic Gonadotropin (hCG)

4.Human Placental Lactogen (hPL)

Progesterone:

•**Production**: Initially produced by the **corpus luteum**, and later by the **placenta** during pregnancy.

•**Functions of Progesterone**:

- **Maintains uterine lining** to support implantation of the zygote.
- **Reduces uterine contractions** to help prevent **spontaneous abortion** (miscarriage).
- **Prepares the glands of the breasts** for lactation.
- Stimulates **testes to produce testosterone**, which is essential for the male fetus in developing the **reproductive tract**.

This list provides an overview of the key placental hormones, with specific emphasis on **progesterone** and its critical functions during pregnancy.

Estrogen plays a critical role in both the physiological processes directly related to pregnancy and several other bodily changes that are not directly tied to pregnancy.

Functions Related to Pregnancy:

1.Stimulates Uterine Growth:

1. Estrogen promotes the expansion and growth of the uterus to accommodate the developing fetus. This includes both the smooth muscle tissue and the blood supply within the uterus.

2.Increases Blood Flow to Uterine Vessels:

1. Estrogen helps to enhance blood flow to the uterine vessels, ensuring adequate oxygen and nutrients are delivered to the growing fetus.

3.Stimulates Breast Duct Development:

1. Estrogen stimulates the growth of the ducts in the breasts, preparing the mammary glands for lactation post-delivery. It also contributes to the enlargement of the breasts during pregnancy.

Effects Not Directly Related to Pregnancy:

1.Increased Skin Pigmentation:

1. Estrogen influences pigmentation changes, such as the darkening of the skin, which can lead to the development of melasma (often referred to as the "mask of pregnancy") on the face. This is caused by increased melanin production.

3- Vascular Changes in the Skin:

1. Under the influence of estrogen, women may experience changes in skin vascularity, which can result in visible veins, especially in the breasts and legs. There may also be changes in the mucous membranes of the nose and mouth, contributing to symptoms like congestion.

4- Increased Salivation (Ptyalism):

1. Estrogen can cause an increase in salivation, which is commonly known as ptyalism or "excessive drooling." This is a less common symptom but can occur during pregnancy, often in combination with nausea.

These estrogen-driven changes are part of the body's adjustment to support both the pregnancy and other processes that occur during this period.

Human Chorionic Gonadotropin (hCG):

- **Signal to Corpus Luteum**: hCG informs the corpus luteum that conception has occurred.
- **Sustains Hormone Production**: It prompts the corpus luteum to continue producing estrogen and progesterone to maintain pregnancy.
- **Early Detection**: hCG is detectable in maternal blood 7–9 days after fertilization and is the basis for pregnancy tests.

Human Placental Lactogen (hPL):

- **Increases Glucose for Fetus**: hPL decreases insulin sensitivity in the mother, increasing glucose availability for fetal growth.
- **Metabolic Changes**: It causes mild insulin resistance in the mother, ensuring more glucose is directed to the fetus.

Together, hCG and hPL help sustain pregnancy and provide necessary resources to the developing fetus.

Umbilical Cord:

- **Lifeline Between Mother and Fetus**: The umbilical cord connects the fetus to the placenta, facilitating the exchange of nutrients, oxygen, and waste products.
- **Blood Vessels**: It contains two arteries that carry deoxygenated blood away from the fetus and one vein that returns oxygenated blood to the fetus.
- **Wharton's Jelly**: This gelatinous substance surrounds and cushions the cord's blood vessels, protecting them and helping to keep the vessels separated.
- **Vessel Coiling**: The blood vessels within the cord are coiled, which allows for movement and stretching while maintaining proper circulation.
- **Normal Length**: The typical length of the umbilical cord is about 55 cm (22 inches).
- **Placental Attachment**: The umbilical cord usually protrudes from the center of the placenta, connecting it to the fetus.

The umbilical cord is essential for the fetus's development, providing vital connections for nutrient and waste exchange with the mother.

- .

Fetal Circulation:

After the fourth week of gestation, fetal circulation through the placenta becomes well established. Since the fetus does not breathe air and the liver doesn't need to process waste products in the same way as after birth, special circulatory diversions are necessary. These diversions, called fetal circulatory shunts, allow blood to bypass certain organs:

1.Ductus Venosus:

1. This shunt diverts some blood away from the liver as it returns from the placenta, directing it into the inferior vena cava for further circulation to the heart.

2.Foramen Ovale:

1. This opening between the right and left atria of the heart allows most of the blood to bypass the lungs (which are not yet in use) and flow directly from the right atrium to the left atrium.

3.Ductus Arteriosus:

1. This shunt connects the pulmonary artery to the aorta, diverting most of the blood away from the lungs and directly into the aorta to be circulated throughout the body.

These circulatory shunts are crucial for ensuring that the fetus receives the oxygen and nutrients it needs from the placenta while bypassing the non-functioning lungs and liver. After birth, these shunts close as the fetus begins to breathe air and its organs take on their full functional roles.

Fetal Circulation Before Birth:

1.Oxygenated Blood Enters the Fetal Body:

1. Oxygenated blood from the placenta enters the fetal body through the **umbilical vein**.

2.Blood Diverted to Liver and Inferior Vena Cava:

1. About half of the blood goes to the liver through the **portal sinus**, while the rest bypasses the liver and enters the **inferior vena cava** via the **ductus venosus**.

3.Right Atrium to Left Atrium:

1. Blood in the inferior vena cava enters the **right atrium** of the heart, where most of it flows directly into the **left atrium** through the **foramen ovale** (bypassing the lungs).

4.Small Amount to the Lungs:

1. A small portion of blood is pumped from the right ventricle to the **lungs** for minimal circulation, as the lungs are not yet in use for oxygen exchange.

5.Blood Flow to the Body:

1. The remaining blood from the right ventricle mixes with blood from the left ventricle and is diverted into the **aorta** via the **ductus arteriosus**, bypassing the lungs.

6.Return of Waste Products:

1. After circulating through the fetal body, blood containing waste products is returned to the placenta through the **umbilical arteries** for disposal.

This unique circulatory system ensures that the fetus receives oxygen and nutrients from the placenta, while bypassing the non-functional lungs and liver until birth.

Circulation After Birth:

1.Closure of the Foramen Ovale:

1. After birth, the **foramen ovale** closes because the pressure in the **right side of the heart** decreases as the **lungs fully inflate**, reducing resistance to blood flow. This forces blood to flow through the lungs for oxygenation, closing the foramen ovale.

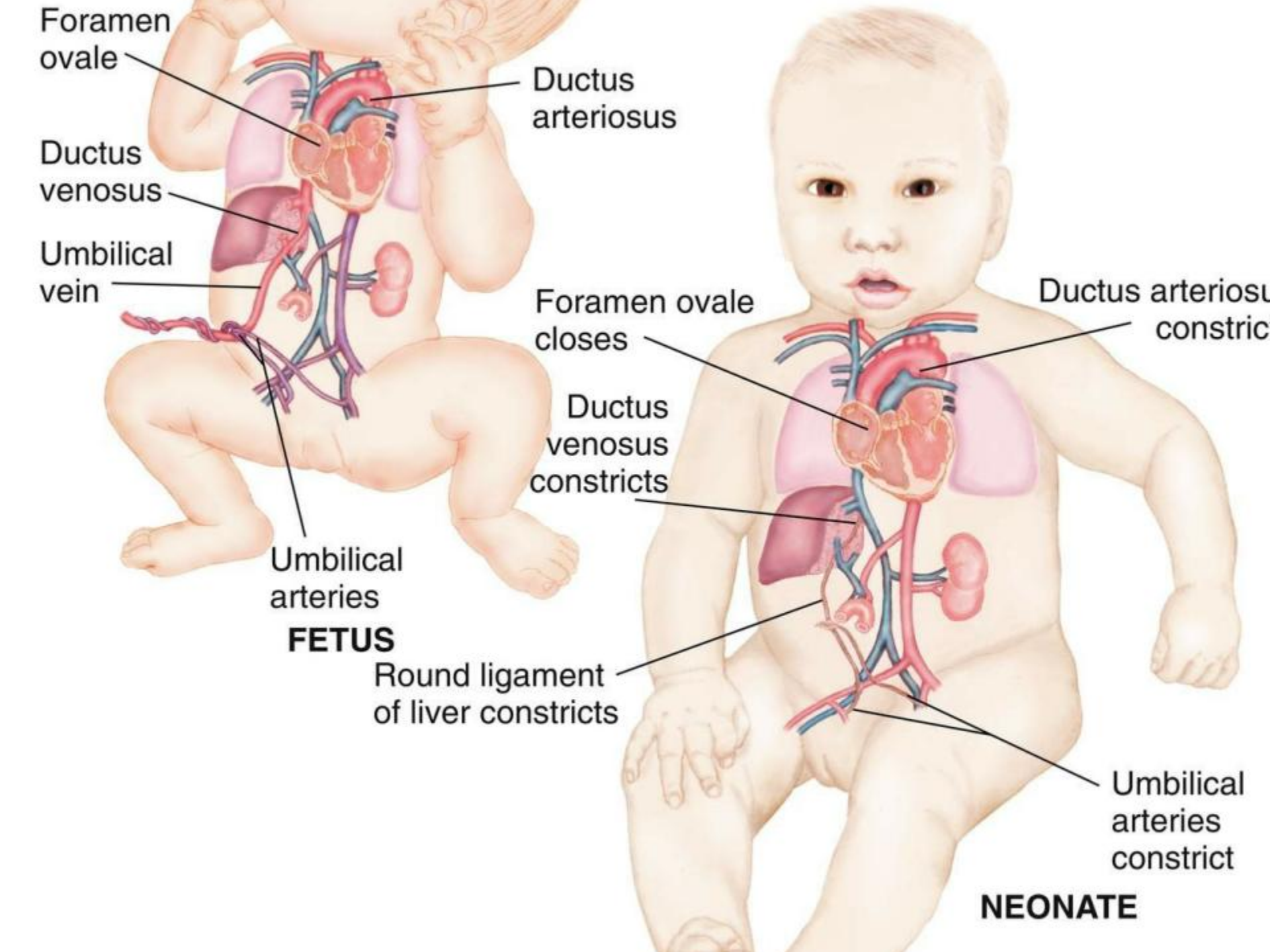
2.Contraction of the Ductus Arteriosus:

1. With the rise in **blood oxygen levels** after birth, the **ductus arteriosus** constricts. This shunt, which previously bypassed the lungs, closes as the infant begins to breathe and use the lungs for oxygen exchange.

3.Closure of the Ductus Venosus:

1. The **ductus venosus** closes once the **flow from the umbilical cord** stops, as the umbilical cord is no longer connected to the placenta after birth.

These changes mark the transition from fetal to neonatal circulation, with blood now circulating through the lungs for oxygenation and the shunts closing as the infant's organs begin functioning independently.


Foramen ovale
Ductus arteriosus
Ductus venosus
Umbilical vein
Umbilical arteries
FETUS
Foramen ovale closes
Ductus arteriosu constric
Ductus venosus constricts
Round ligament of liver constricts
Umbilical arteries constrict
NEONATE

Closure of Fetal Circulatory Shunts:

1.Foramen Ovale:

1. **Functionally closes** within 2 hours after birth as the pressure changes in the heart due to lung inflation.
2. **Permanently closes** by around 3 months of age.

2.Ductus Arteriosus:

1. **Functionally closes** within 15 hours after birth.
2. **Permanently closes** in about 3 weeks, forming a ligament.

3.Ductus Venosus:

1. **Functionally closes** immediately when the umbilical cord is cut.
2. **Permanently closes** in about 1 week, also becoming a ligament.

Potential for Reopening:

•**Foramen Ovale**: Conditions that impede full lung expansion (e.g., **respiratory distress syndrome**) can increase resistance to blood flow from the heart to the lungs, causing the foramen ovale to **reopen**.

•**Ductus Arteriosus**: Similarly, conditions that reduce blood oxygen levels (e.g., respiratory distress) may prevent the **ductus arteriosus** from closing, leading to it **remaining open**.

Once these shunts permanently close, the **ductus arteriosus** and **ductus venosus** become ligaments, completing the transition to the adult circulatory system.

Fetal Lung Preparation for Birth:

1.Lung Fluid Function:

1. The fluid in the fetal lungs plays a crucial role in maintaining **lung expansion** and promoting **lung growth** during pregnancy.

2.Decrease in Lung Fluid During Labor:

1. As labor progresses, the amount of lung fluid decreases, preparing the lungs for the transition to **extrauterine breathing** (breathing air outside the womb).

3.Hormonal Changes:

1. Several hormones increase during labor, which help to **decrease lung fluid production** and **increase lung fluid resorption**, making the lungs ready to accept air at birth.

4.Cesarean Sections and Rapid Deliveries:

1. In cases of **cesarean sections** or **rapid deliveries**, this natural process of lung fluid reduction is often limited. This can lead to a condition known as **"wet lung"**, where excess lung fluid remains, potentially causing breathing difficulties in the newborn.

This process ensures the newborn's lungs are prepared to function properly after birth, but complications can arise if the fluid reduction doesn't occur efficiently.

Impact of Fetal Development on Adult Health:

1.Exposure to External Influences:

1. During the first 3 months of fetal life, the fetus is particularly at risk to external factors, such as **undernutrition**, which can affect its development.

2.Intrauterine Growth Restriction (IUGR):

1. Infants with **intrauterine growth restriction** may have a reduced number of cells in their organs, making them more susceptible to specific diseases later in life.

3.Pancreatic Beta Cells and Insulin Secretion:

1. A reduced number of **pancreatic beta cells** due to poor fetal nutrition can impair insulin secretion, leading to **metabolic issues** such as **diabetes** in adulthood.

4.Influence of Lifestyle Factors:

1. **Obesity**, **inactivity**, and other factors in adulthood can influence the onset and severity of diseases that may have roots in fetal development, such as **insulin resistance** or **cardiovascular diseases**.

5.Impact on Vascular, Renal, and Hormonal Systems:

1. Malnutrition during pregnancy can lead to changes in fetal **vascular**, **renal**, or **hormonal systems**, which may increase the risk of **hypertension** (high blood pressure) in later life.

6.Impaired Fetal Liver Growth: **Impaired liver growth** during late gestation, often due to malnutrition, can permanently affect **lipid metabolism** and predispose the individual to **high cholesterol** levels in adulthood.

7.Measuring Liver Size at Birth: **Reduced liver size** can be detected by measuring the **abdominal circumference** at birth, which may serve as an indicator of potential metabolic issues in adulthood.

Get Ready for the NCLEX® Examination!

Key Points:

- The uniqueness of each individual results from the blending of genes on the 46 chromosomes contained in each body cell and the environment of the embryo and fetus during development.
- Gametogenesis in the male is called spermatogenesis.
- Each mature sperm has 22 autosomes plus either an X or a Y sex chromosome for a total of 23.
- Gametogenesis in the female is called oogenesis.
- It begins at ovulation and is not completed until fertilization occurs.
- The mature ovum has 22 autosomes plus the X sex chromosome for a total of 23.
- At conception the total number of chromosomes is restored to 46.
- When the ovum is fertilized by an X-bearing sperm, a female offspring results; when it is fertilized by a Y-bearing sperm, a male offspring results.
- After fertilization in the fallopian tube, the zygote enters the uterus, where implantation is complete by 7 days after fertilization.
- If the zygote fails to move through the tube, implantation occurs there, and a tubal ectopic pregnancy results.

• When implantation occurs in the uterine lining, the cells of the zygote differentiate and develop into the following structures: chorion, amnion, yolk sac, and primary germ layers.

1. The chorion develops into the embryonic or fetal portion of the placenta;
2. the amnion encloses the embryo and the amniotic fluid;
3. the primary germ layers develop into different parts of the growing fetus;
4. and the yolk sac, which functions only during embryonic life, begins to form red blood cells.

• The three germ layers of the embryo are the ectoderm, the mesoderm, and the endoderm.

All structures of the individual develop from these layers.

• All body systems are formed and functioning in a simple way by the end of the eighth week.

• The accessory structures of pregnancy are the placenta, umbilical cord, and fetal circulation.

These structures continuously support the fetus throughout prenatal life in preparation for birth.

• The amniotic fluid maintains an even temperature around the fetus, allows free floating and symmetrical growth, and acts as a cushion to protect the fetus and the umbilical cord.
• The placenta is an organ for fetal respiration, nutrition, and excretion. It is also a temporary endocrine gland that produces progesterone, estrogen, human chorionic gonadotropin, and human placental lactogen.
• The umbilical cord contains two arteries that carry blood away from the fetus and one vein that carries blood to the fetus.
• Fetal circulation transports oxygen and nutrients to the fetus and disposes of carbon dioxide and other waste products from the fetus.
The temporary fetal circulatory structures are the foramen ovale, the ductus arteriosus, and the ductus venosus. They divert most blood from the fetal liver and lungs because these organs do not fully function during prenatal life.
• Monozygotic twins develop from a single ovum and are identical. Dizygotic twins develop from two separate ova and two separate sperm and have a separate amnion and placenta.

Review Questions for the NCLEX® Examination:

1-The child's sex is determined by the:

- dominance of either the X or the Y chromosome.
- number of X chromosomes in the ovum.
- ovum, which contributes either an X or a Y chromosome.
- sperm, which contains either an X or a Y chromosome.

2. A woman who wants to become pregnant should avoid all medications unless they are prescribed by a physician who knows she is pregnant because:

1. the placenta allows most medications to cross into the fetus.
2. medications often have adverse effects when taken during pregnancy.
3. fetal growth is likely to be slowed by many medications.
4. the pregnancy is likely to be prolonged by some medications.

3. When a couple has unprotected sexual intercourse 3 days before the woman ovulates, the risk of the woman becoming pregnant is:

1. limited because the ova lives only for 24 hours.
2. very high because both the ova and the sperm are capable of fertilizing at that time.
3. unknown.
4. very low because that is not the woman's "fertile period."

What is the likelihood of becoming pregnant on each day before or after ovulation?

5 days before ovulation	**10%**
3 days before ovulation	14%
2 days before ovulation	27%
1 day before ovulation	31%
Ovulation day	33%

4. The purpose of the foramen ovale is to:

1. increase fetal blood flow to the lungs.
2. limit blood flow to the liver.
3. raise the oxygen content of fetal blood.
4. reduce blood flow to the lungs.

allows blood to cross the atria and bypass pulmonary circulation during fetal development.

1. Why are twins often born early?

1- The uterus becomes over distended.

2- The placenta becomes distended.

3. The woman's body cannot tolerate the weight.

4. The fetuses become too large to deliver vaginally.

6. The nurse is responsible to examine the umbilical cord of the newborn infant. The nurse knows that:

a. the umbilical cord has 2 veins and 1 artery

b. the umbilical cord has 2 arteries and 1 vein

c. the umbilical cord has 2 arteries and 2 veins

d. umbilical arteries carry blood away from the fetus

e. umbilical arteries carry blood to the fetus

1. a and e
2. 2. b and e
3. 3. b and d 4. c and d

There is a high chance of becoming pregnant if a person has sex within 12–24 hours after ovulation.

Critical Thinking Questions :

1. A patient discusses her family planning decisions. She states that she will come to the clinic for prenatal care and will begin to take prenatal vitamins as soon as she knows she is pregnant.

What would be the best response from the nurse?

1. A patient at 32 weeks gestation states that she wants to deliver her infant now because she feels so “big and uncomfortable.” She states that she knows the infant has been fully formed since the first trimester and does not mind if it is a little small at birth. What would be the best response from the nurse?

Leifer, G. (2019). Introduction to maternity and pediatric nursing.

Thanks very much