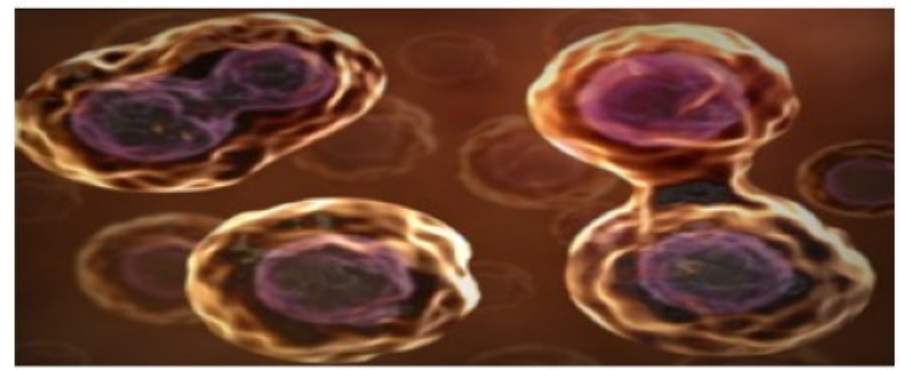
An –Najah National University
Faculty of Medicine and Health Science
Nursing & Midwifery Department

Unit 4: Cell Division



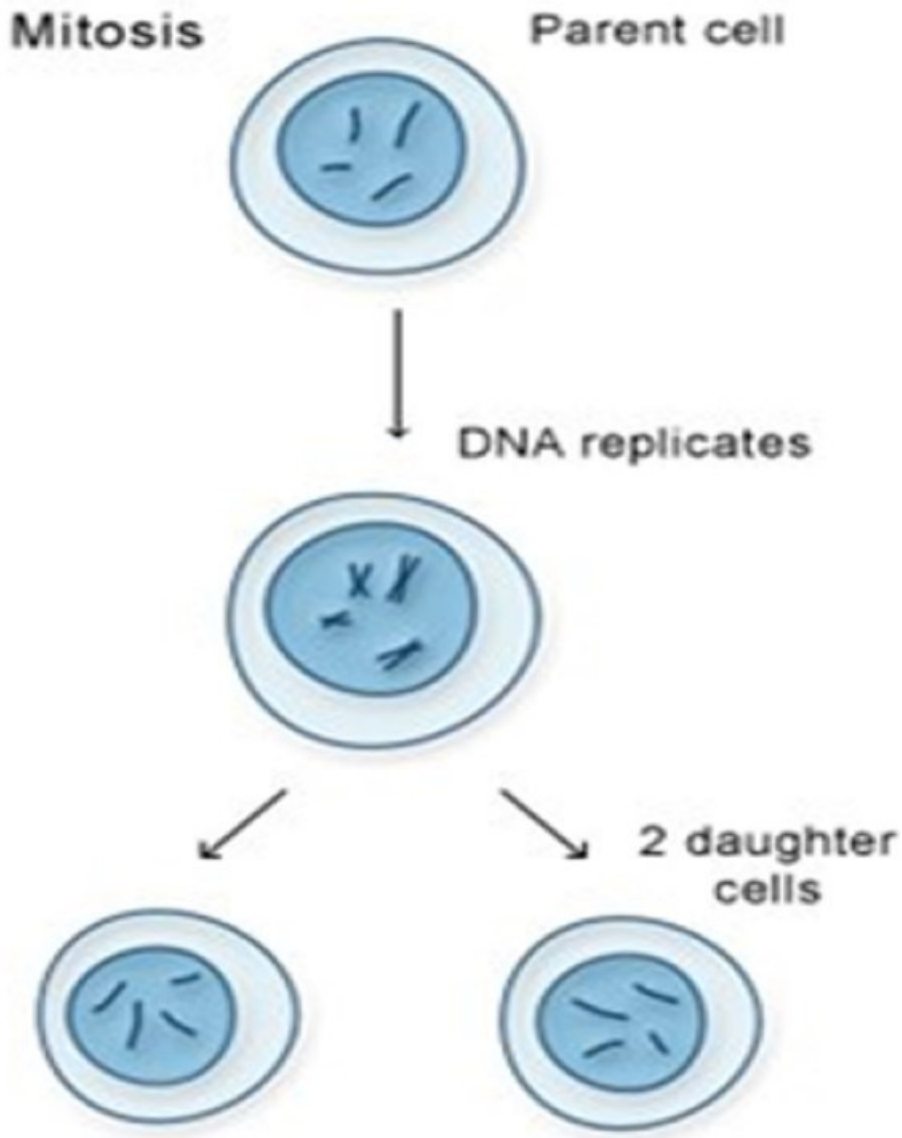
Shurouq G. Qadous

BSN, MSN, PhD candidate

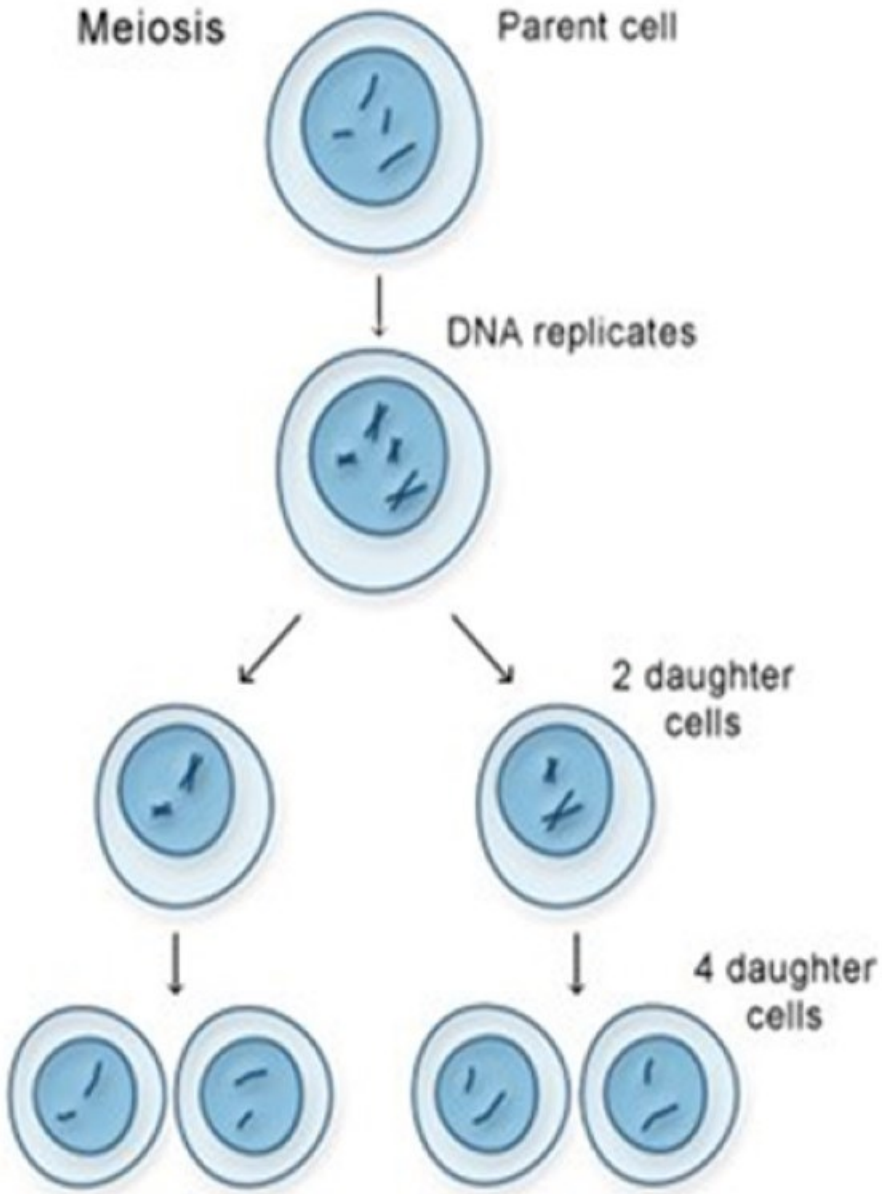
Cells are reproduced by two different methods:

1. Mitosis body cell replicate to yield two cells with the same genetic makeup as the parent cell.

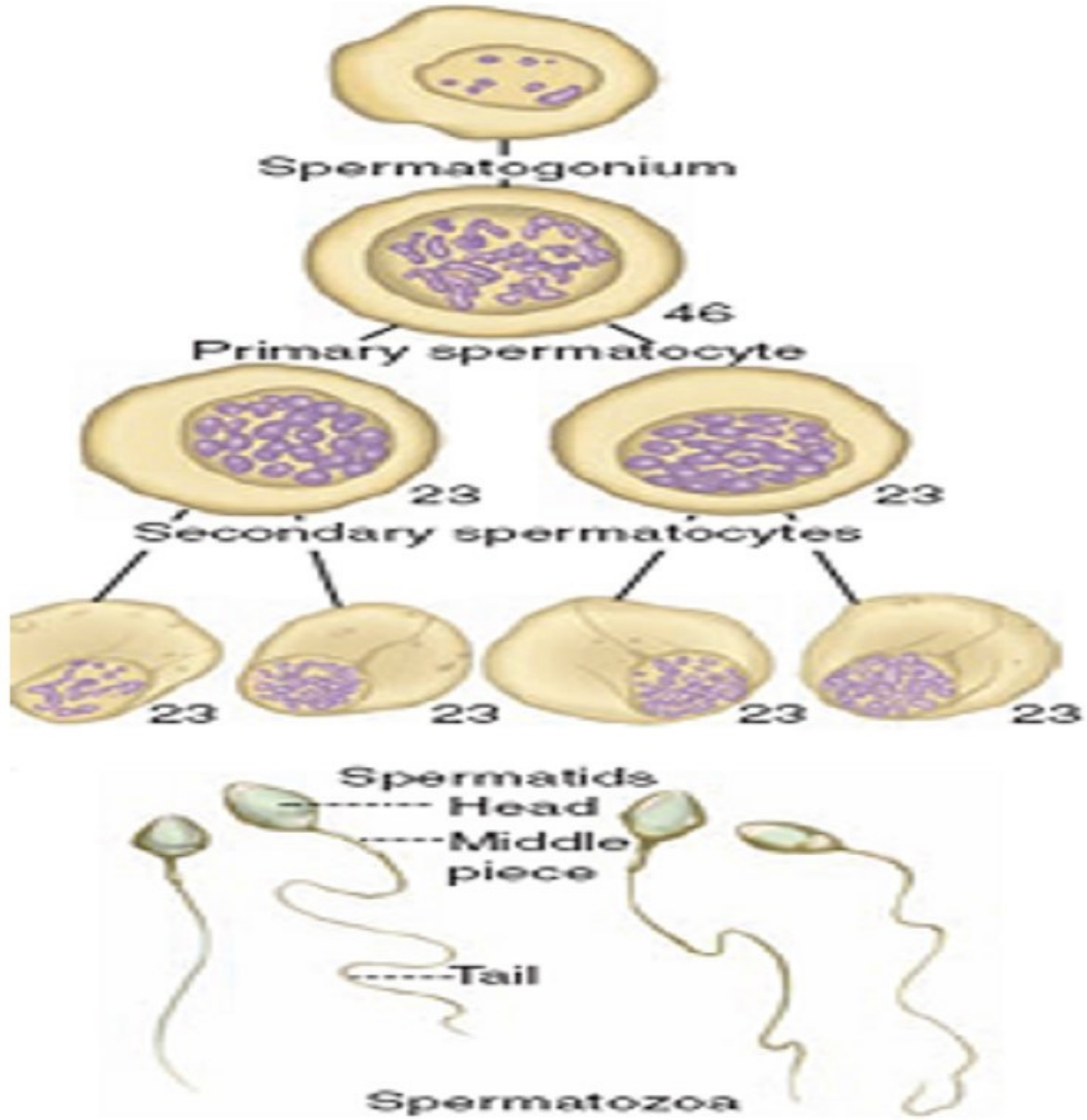
- First cell make a copy of its DNA, then it divides with each daughter cell receiving one copy of the genetic material.
- **Mitotic division facilitates growth and development or cell replacement.**



2. Meiosis الانقسام لاختزالي by which germ cells divide and decrease their chromosomal number by half, produces gametes (eggs and sperm).

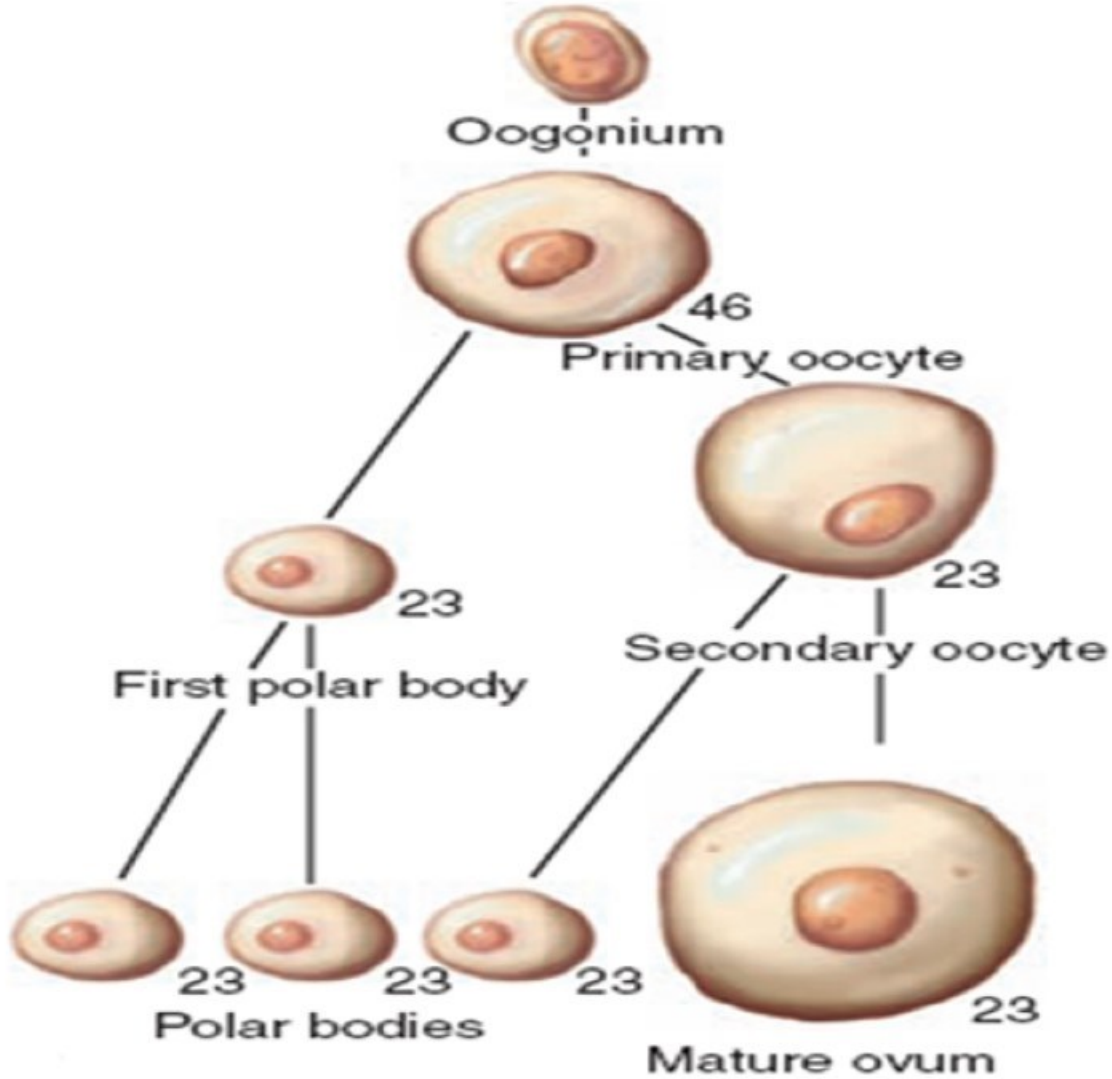


- Cells that undergo meiosis in the male are called **spermatocytes**. The primary spermatocyte, which undergoes the first meiotic division, contains the diploid number of chromosomes عدد ثنائي من الكروموسوم .
- During the first meiotic division, two haploid secondary spermatocytes are formed.
- Each secondary spermatocyte contains **22 autosomes** and **one sex chromosomes**.
- During the second meiotic division the male produces **two gametes with an X chromosome** and **two gametes with an Y chromosome**, all of which will develop into viable sperm.
- More than 200 million sperm/mL are contained in the ejaculated semen, only one can enter the ovum to fertilize it.

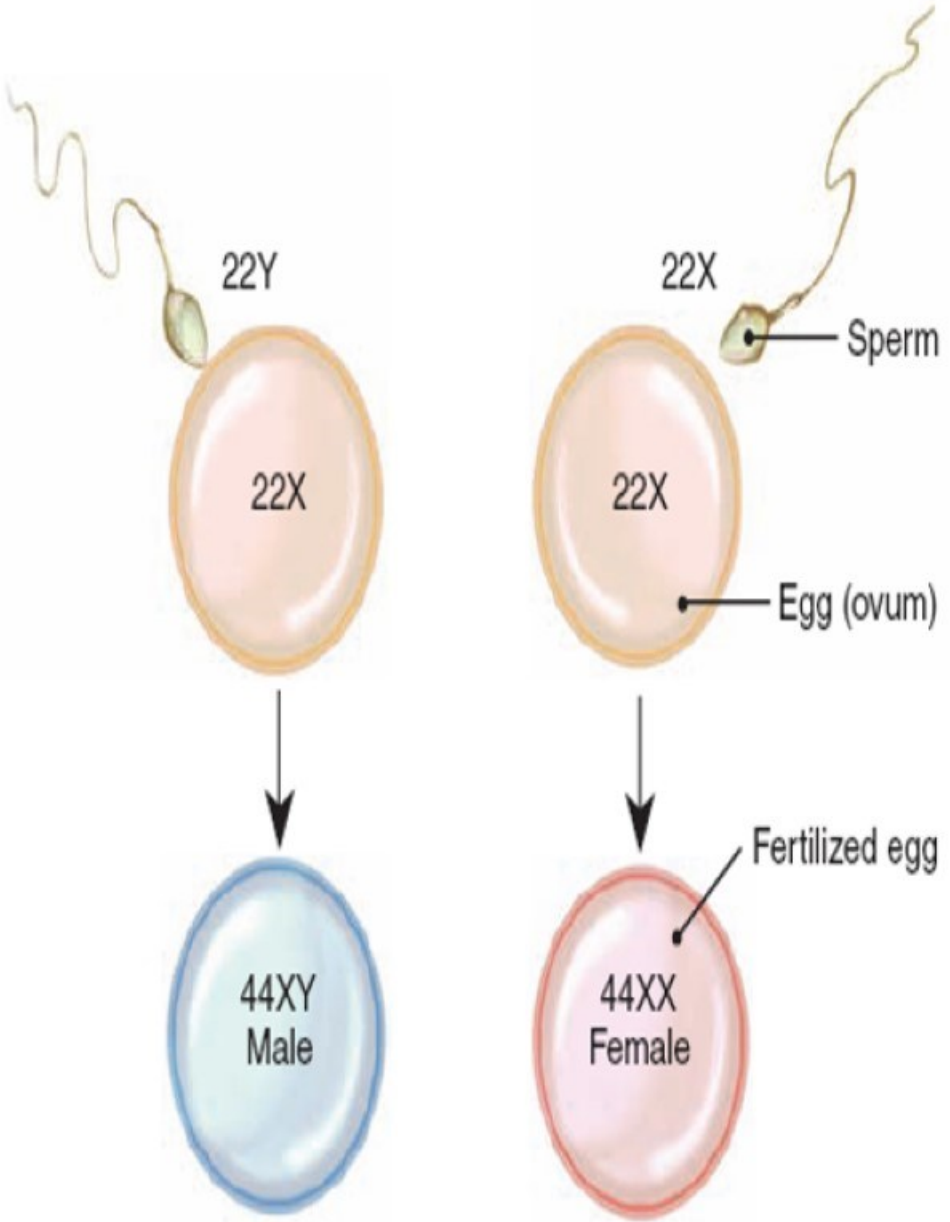

Spermatogonium
46
Primary spermatocyte
23
23
Secondary spermatocytes
23
23
23
23
Spermatids
Head
Middle piece
Tail
Spermatozoa

Oogenesis, the process of ovum formation, begins during fetal life of the female.

- All the cells that may undergo meiosis in a woman's lifetime are contained in her ovaries at birth. The majority of the estimated 2 million primary oocytes degenerate spontaneously.
- Only 400 to 500 ova will mature during the approximately 35 years of a woman's reproductive life.
- The primary oocytes begin the first meiotic division (e.g., they replicate their DNA) during fetal life but remain suspended at this stage until puberty.
- Then, usually monthly, one primary oocyte matures and completes the first meiotic division yielding two unequal cells: the secondary oocyte and a small polar body.
- **Both contain 22 autosomes and one X sex chromosomes.**


Oogonium
46
Primary oocyte
23
First polar body
23
Secondary oocyte
23
23
23
Polar bodies
23
Mature ovum

- At ovulation, the second meiotic division begins. However, the ovum does not complete the second meiotic unless fertilization occurs. At fertilization, a second polar body and the **zygote** (the united egg and sperm) are produced. Polar body degenerate.
- If fertilization does not occur, the ovum also degenerate.



Conception

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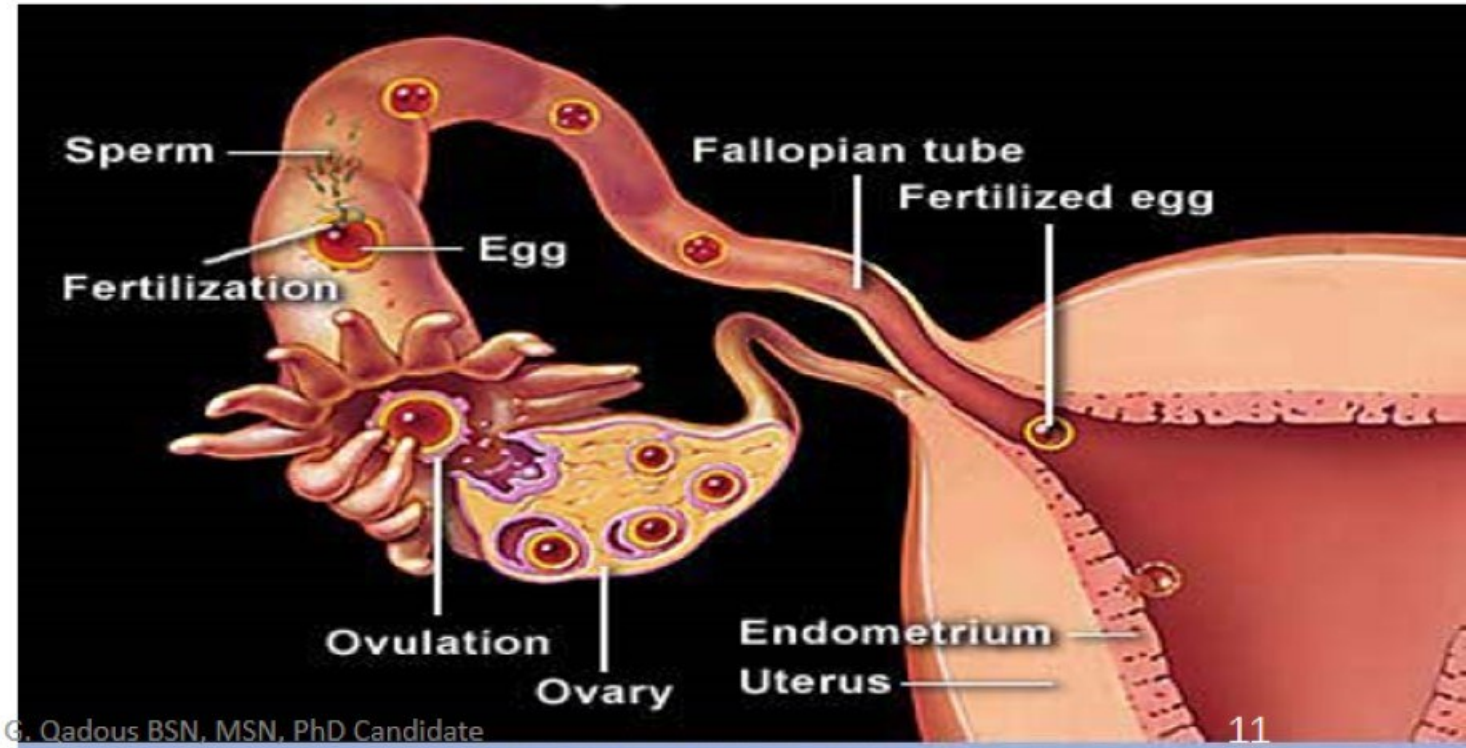
The three stages of fetal development during pregnancy are:

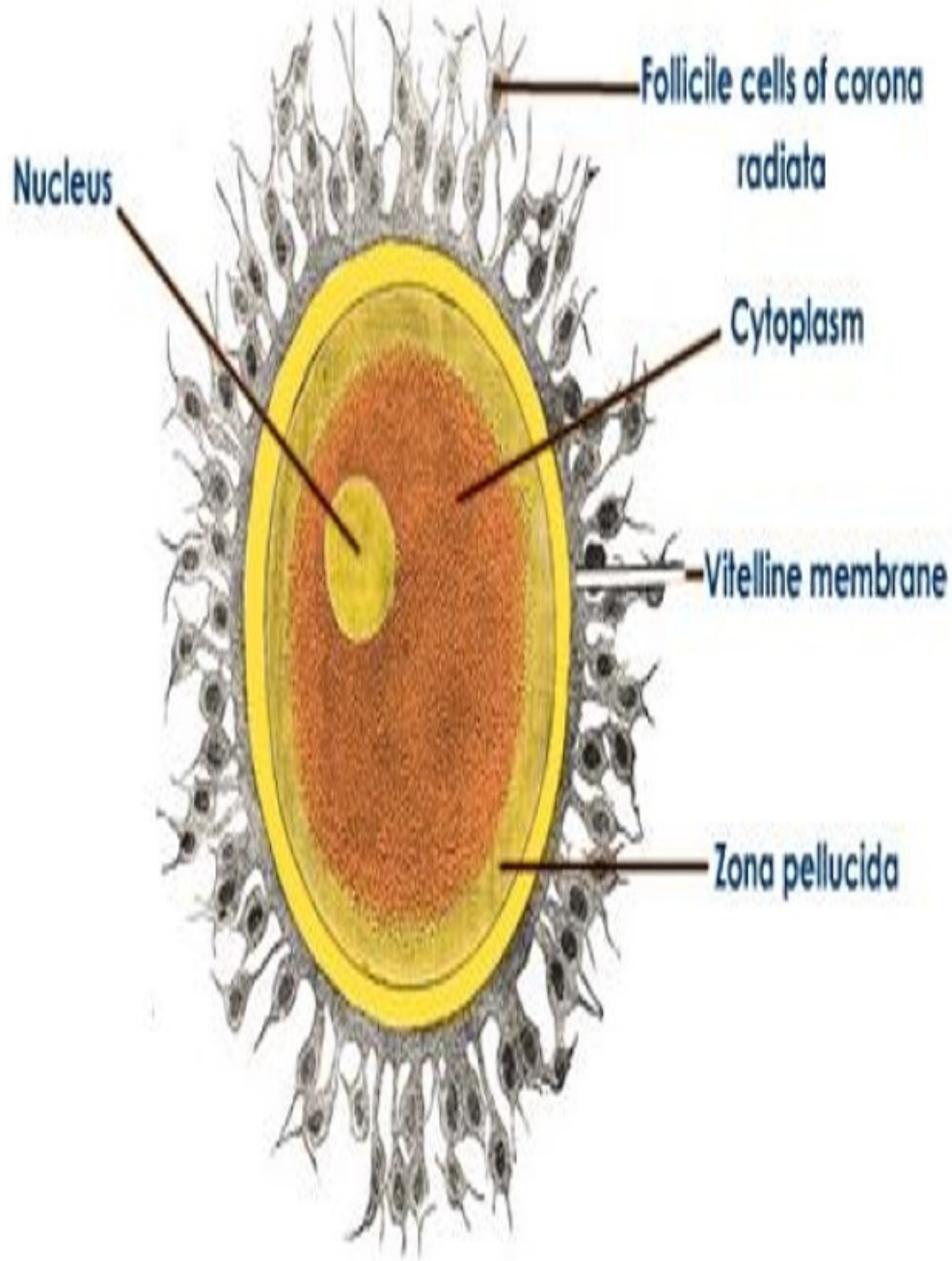
1. **Preembryonic stage**: fertilization through the second week.
2. **Embryonic stage**: end of the second week through the eighth week.
3. **Fetal stage**: end of the eighth week until birth.

- ***Conception,*** defined as the union of a single egg and sperm, marks the beginning of a pregnancy.
- Conception occurs in a sequential process.
- This process includes **gamete** (egg and sperm) formation, **ovulation** (release of the egg), **union of the gametes** (which results in an embryo), and **implantation in the uterus**.



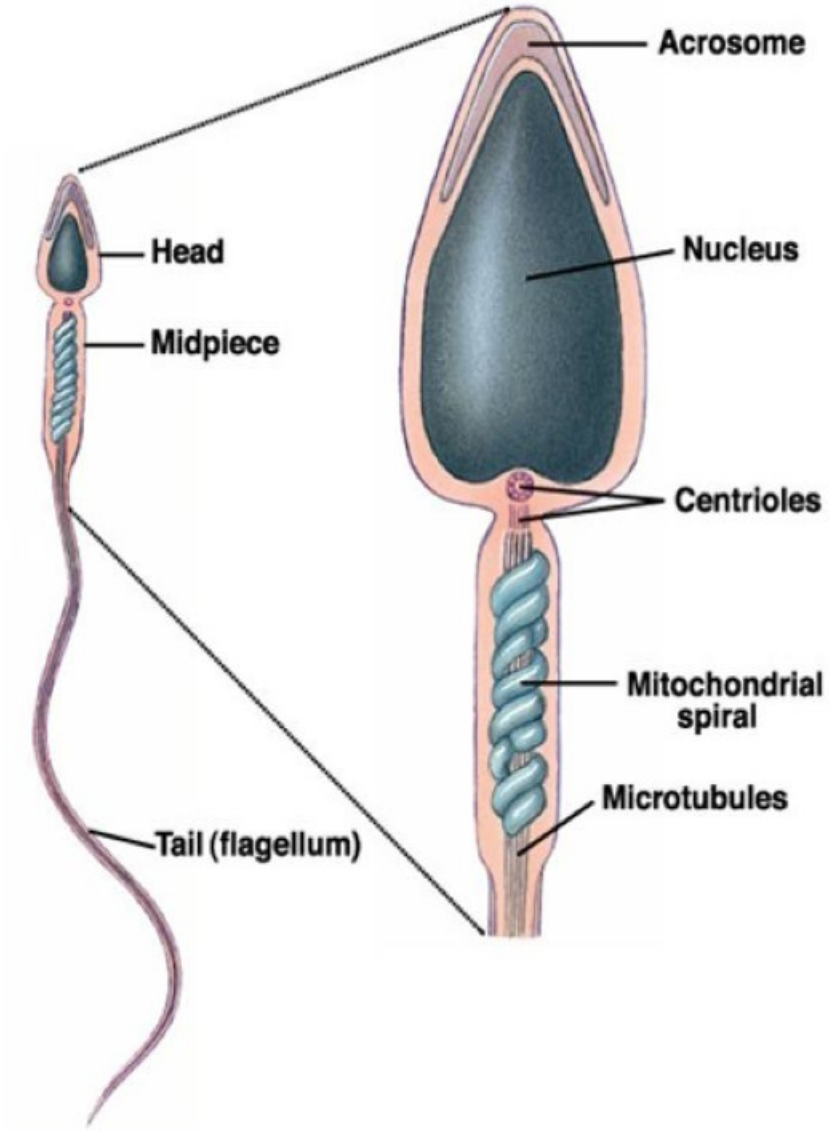
Ovum

- At ovulation the ovum is released from the ruptured ovarian follicle.
- *High estrogen levels increase the motility of the uterine tubes so that their cilia are able to capture the ovum* and propel it through the tube toward the uterine cavity
- 2 protective layers surround the ovum. The inner layer is a thick, cellular layer called the **zona pellucida.** The outer layer called the **corona radiata**, is composed of elongated cells.
- *Ova are considered fertile for about 24 hours after ovulation.*

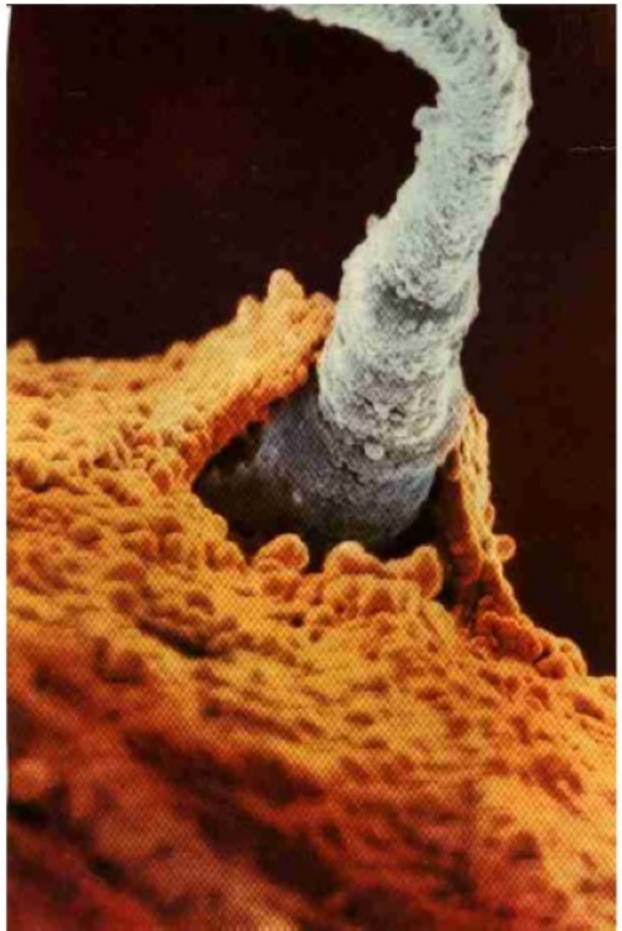


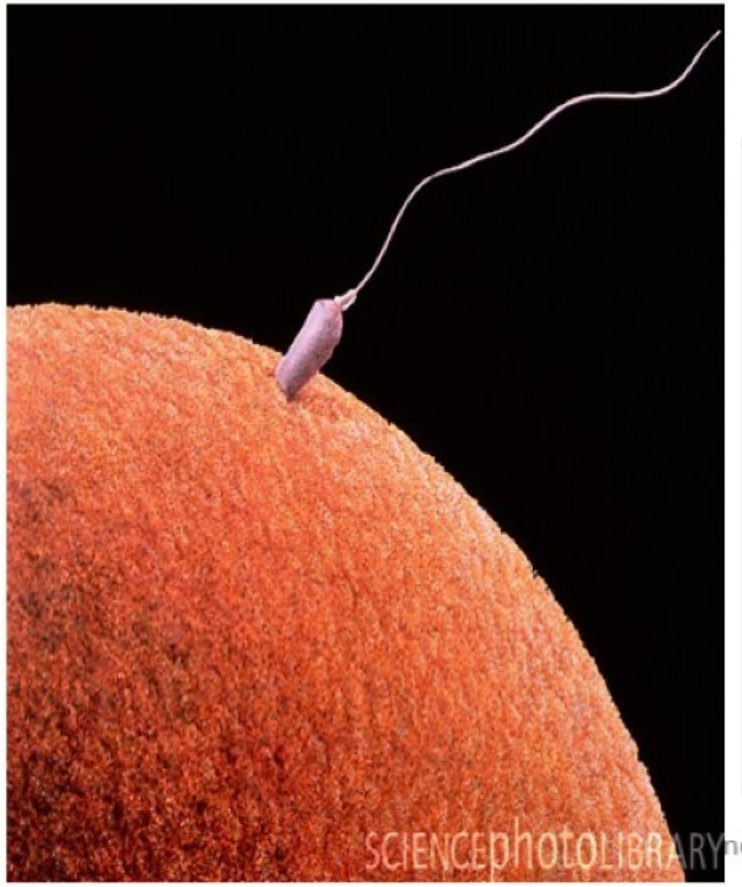
Sperm

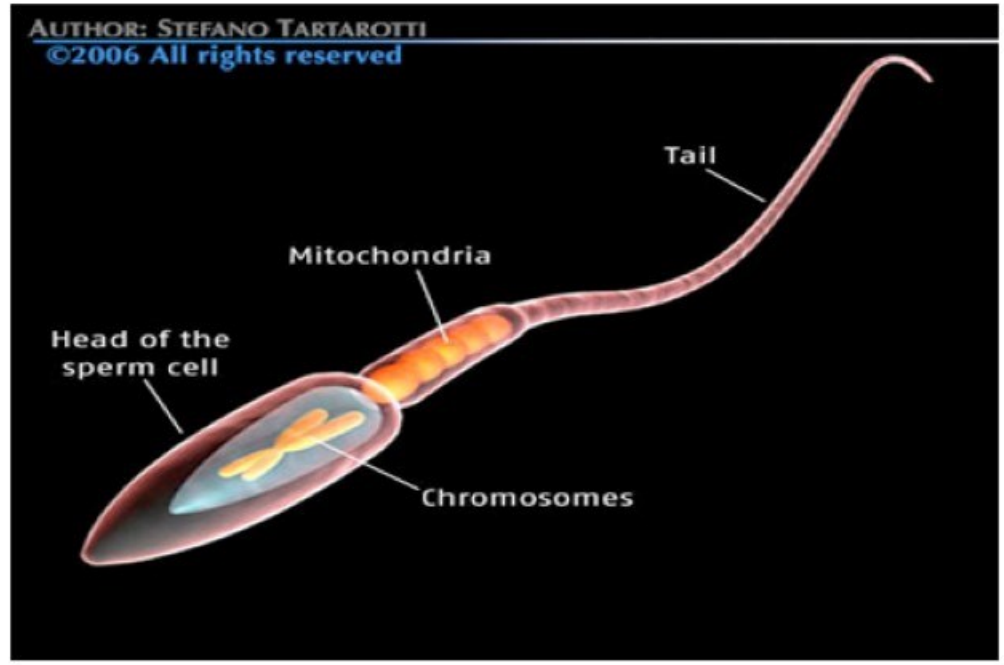
- Ejaculation normally propel almost a teaspoon of semen containing as many as 200 to 500 million sperm into the vagina.
- Sperm swim by **flagellar movement** of their tails.
- Some sperm can reach site of fertilization within 5 min., **but average transit time is 4 to 6 hours**.
- Sperm remain viable within the woman's reproductive system for an average of 2 to 3 days.



- As sperm travel through the female reproductive tract, enzymes (hyaluronidase) are produced to aid in their capacitation (is physiologic change that removes the protective coating from the heads of the sperm).
- These enzymes are necessary for the sperm to penetrate the protective layers of the ovum before fertilization.







ndidate

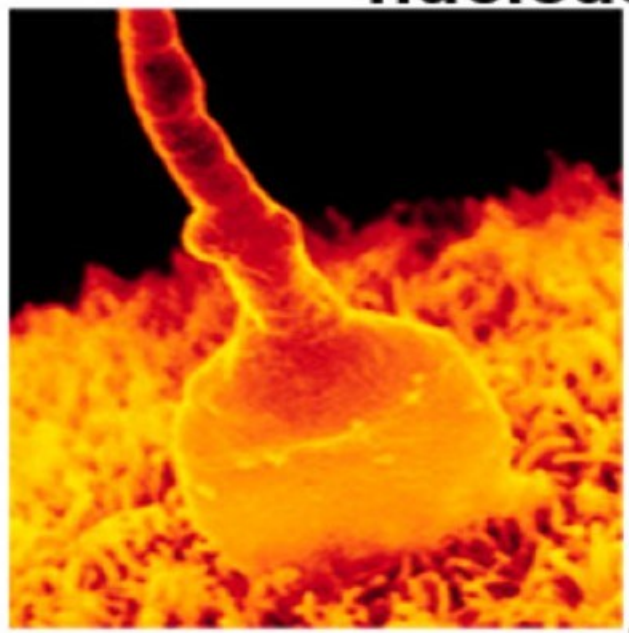
Fertilization

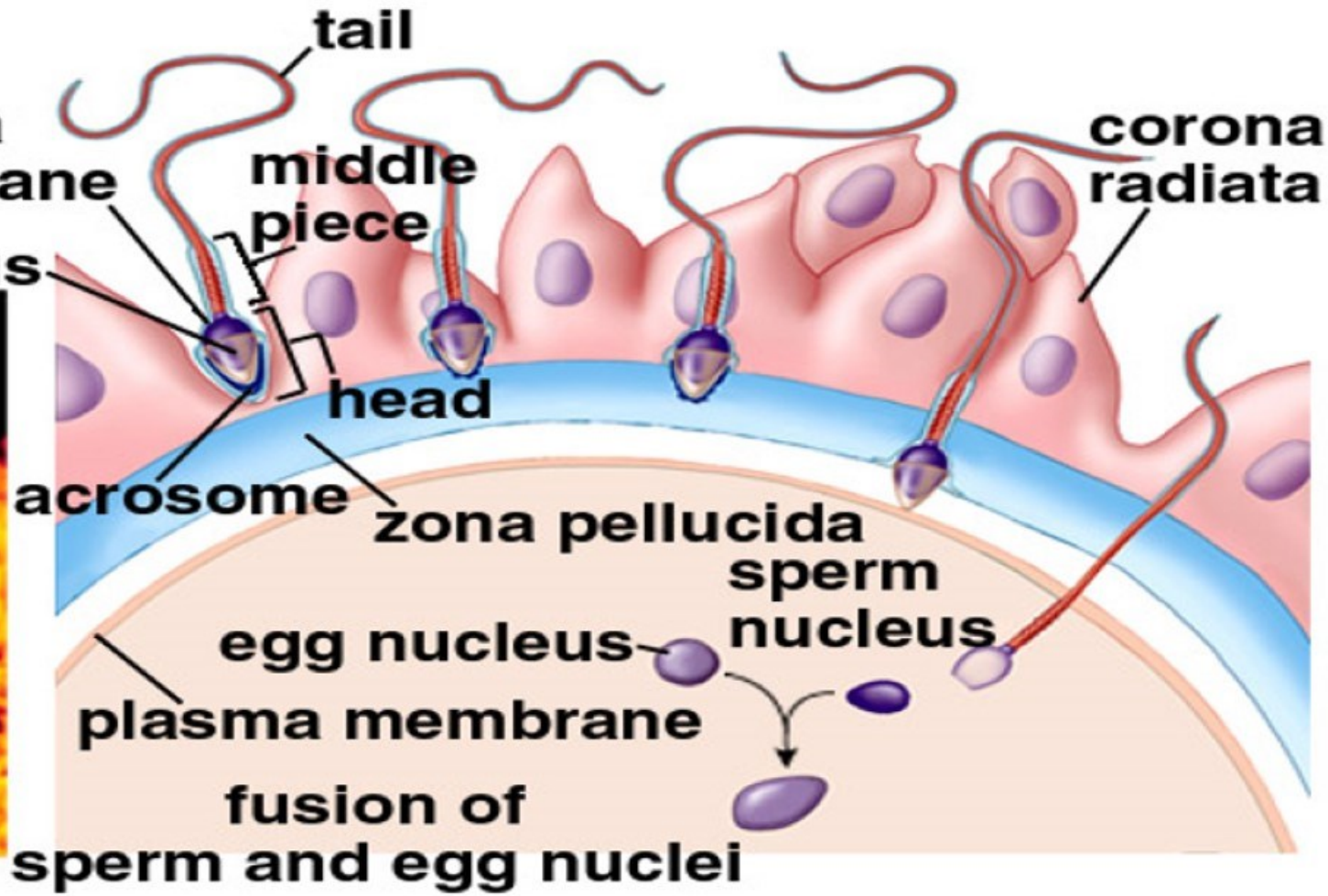
- **Fertilization** takes place in the ampulla (the outer third) of the uterine tube.

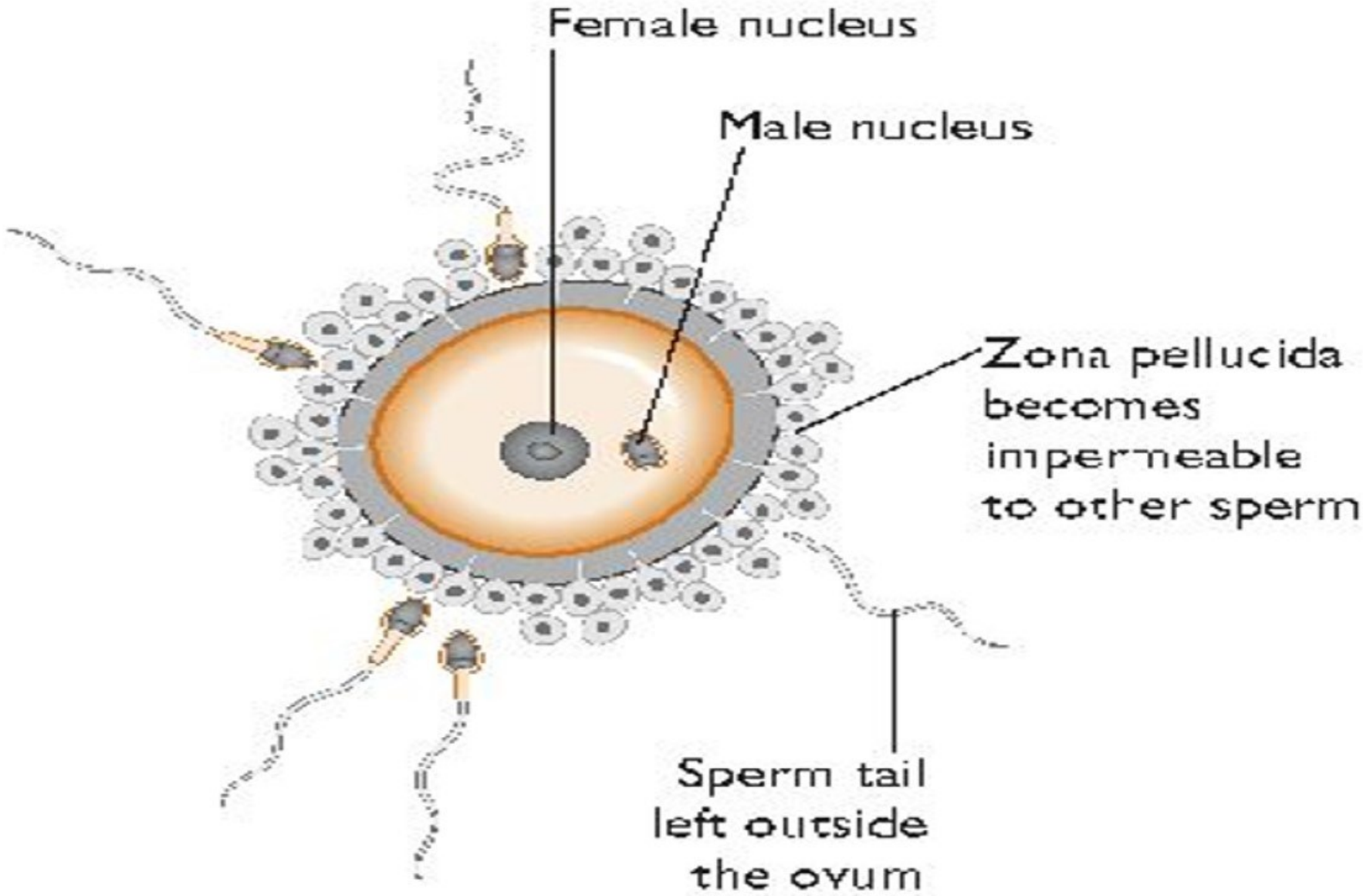
- When a sperm successfully penetrates the membrane surrounding the ovum, both sperm and ovum are enclosed within the membrane, and the membrane becomes impenetrable to other sperm; this process is termed the zona reaction.

- Nuclei from sperm and egg fuse and the chromosomes combine, restoring the diploid number (46).

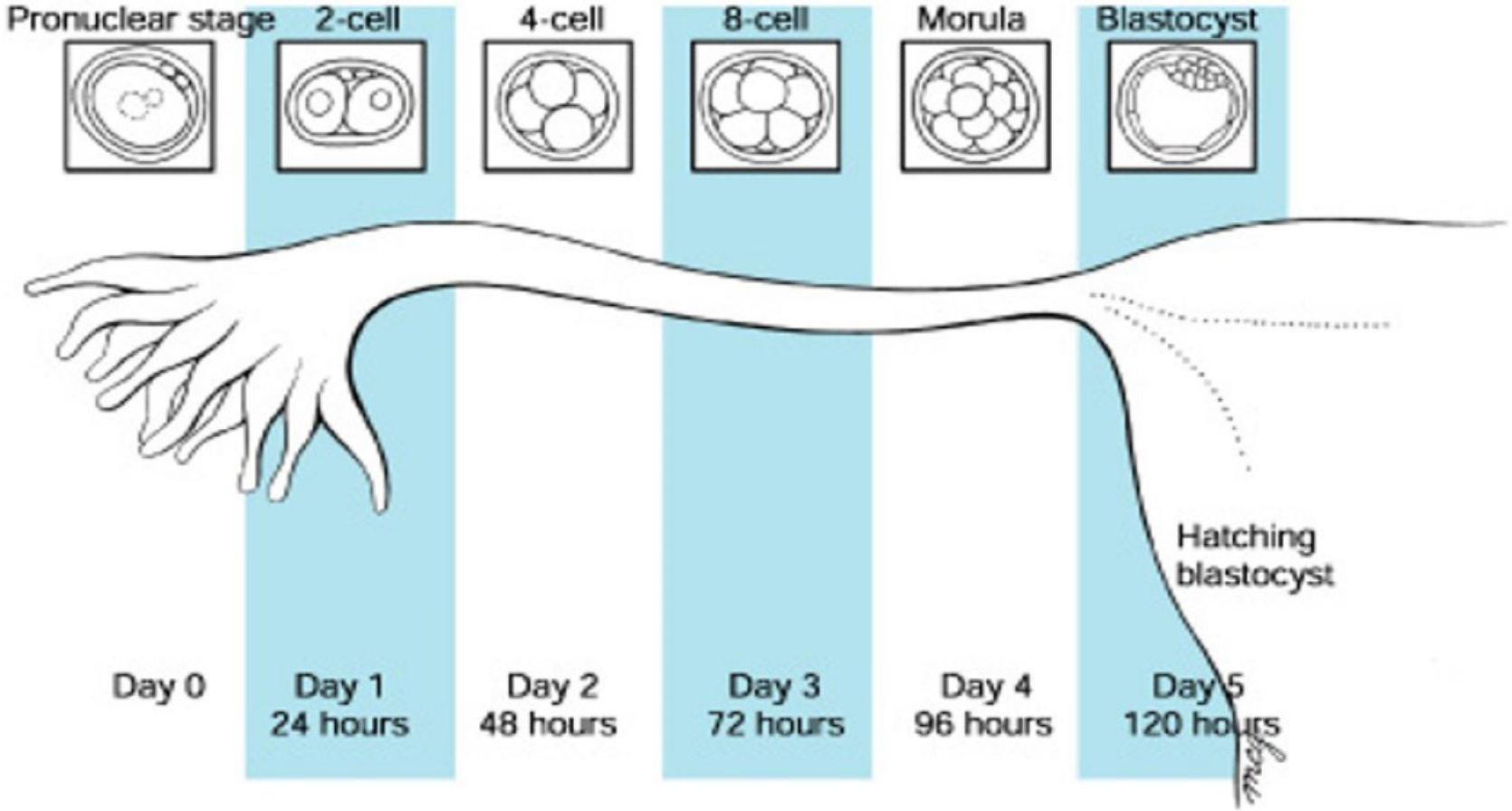
Fertilization






Female nucleus
Male nucleus
Zona pellucida becomes impermeable to other sperm
Sperm tail left outside the ovum

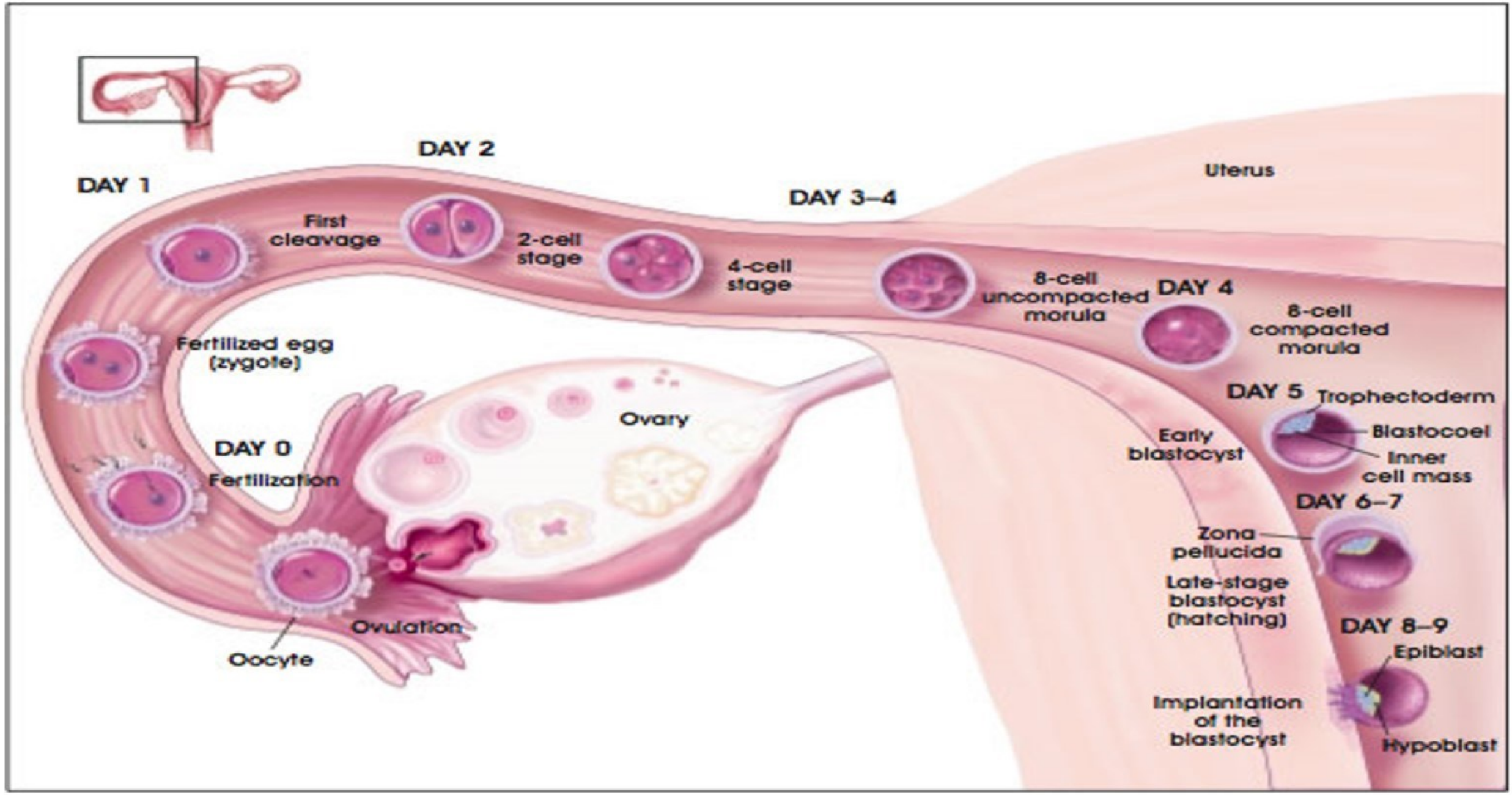
- **Zygote,** the first cell of the new individual has been achieved.
- Mitotic cellular replication تكرار, called **cleavage**, begins as the zygote travels the length of the uterine tube into the uterus. This takes 3 – 4 days.



- Fertilized egg divides rapidly with no increase in size, successively smaller cells, called **blastomeres**, are formed with each division.
- A 16- cell **morula**, a solid ball of cells, is produced within 3 days and is still surrounded by the protective **zona pellucida.** Further development occurs as the morula floats freely within the uterus.
- Fluid passes through the zona pellucida into the intercellular spaces between blastomeres, separating them into parts: the **trophoblast** (which gives rise to the placenta) and the **embryoblast** (which gives rise to the embryo).

- A cavity forms within the cell mass as the spaces come together, forming a structure called the **blastocyst cavity.** When the cavity becomes recognizable, the whole structure of the developing embryo is known as the **blastocyst**.
- Stem cells are derived from the inner cell mass of the blastocyst. The outer layer of cells surrounding the cavity is the trophoblast.

FIGURE 10.4 Blastocyst.



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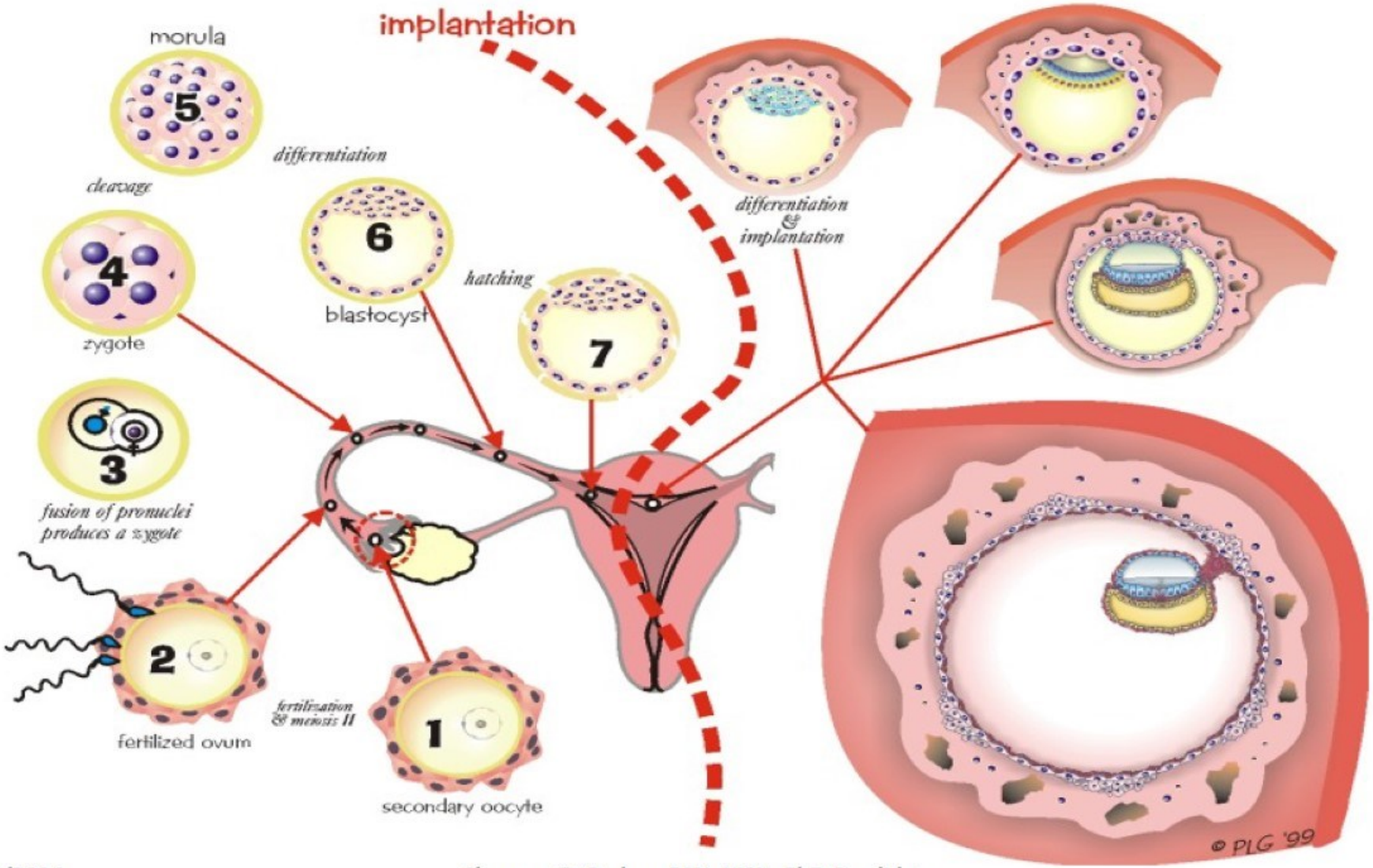
Summary of Preembryonic Development

- Fertilization takes place in ampulla of the fallopian tube.
- Union of sperm and ovum forms a *zygote* (46 chromosomes).
- Cleavage cell division continues to form a *morula*

(mass of 16 cells).

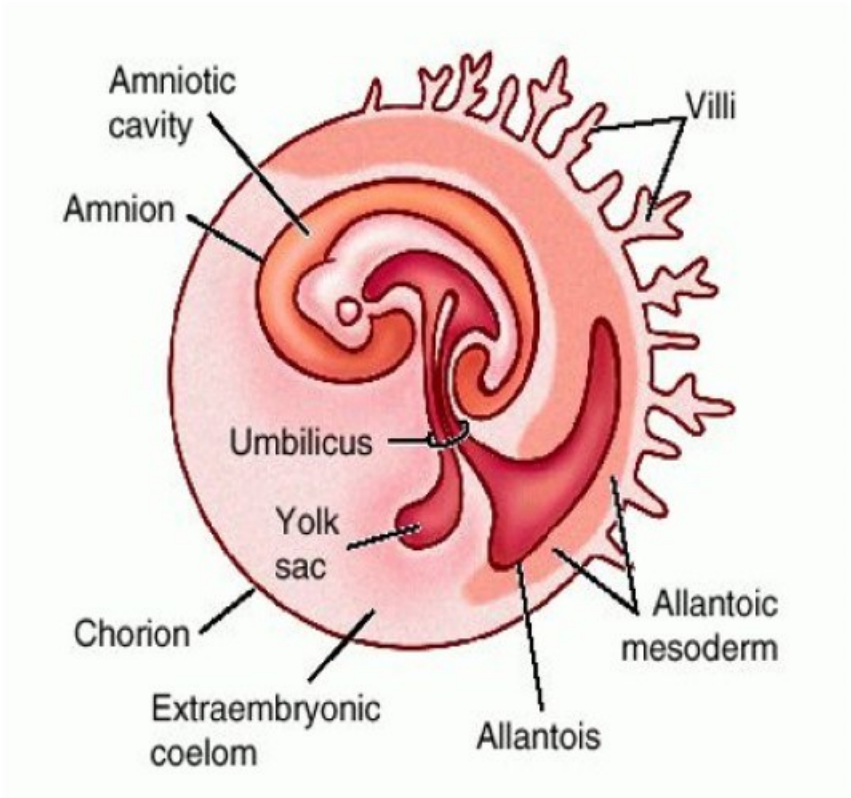
- The inner cell mass is called *blastocyst, which forms* the embryo and amnion.
- The outer cell mass is called *trophoblast, which forms* the placenta and chorion.
- Implantation occurs 7 to 10 days after conception in the endometrium.

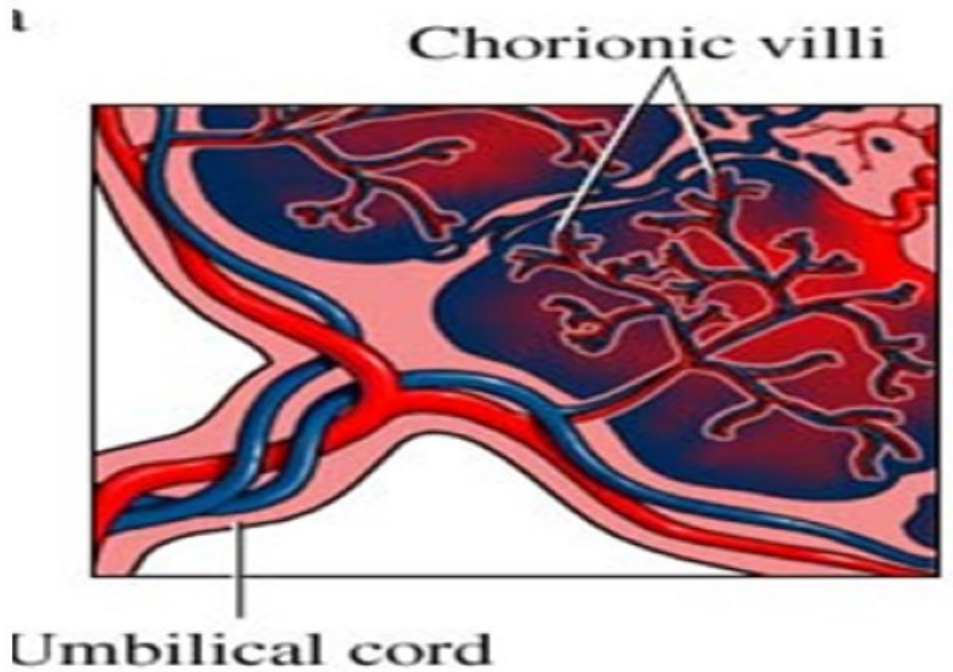
Implantation



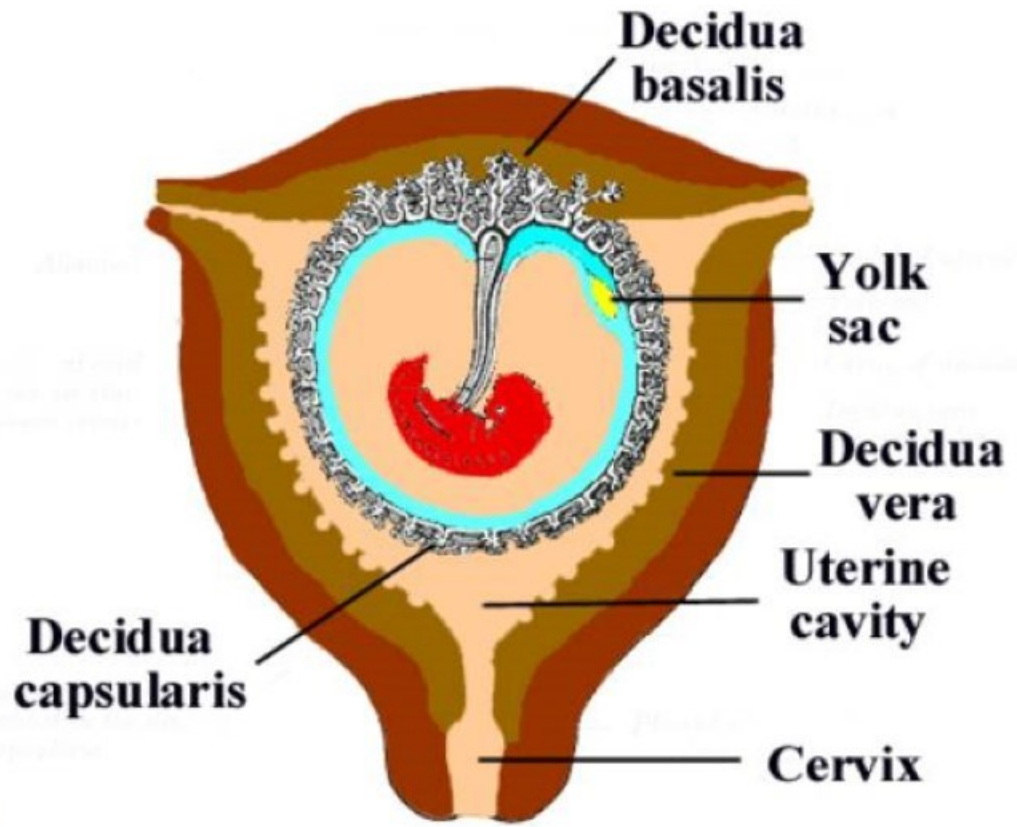
- Zona pellucida degenerates, and the trophoblast attaches itself to the **uterine endometrium**, usually in the anterior or posterior fundal region.
- Between 6 and 10 days after conception, the trophoblast secretes enzymes that enable it to burrow into the endometrium until the entire blastocyst is covered.
- Endometrial blood vessels erode, and some women experience slight implantation bleeding *(slight spotting and bleeding during the time of the first missed menstrual period)*.

- **Chorionic villi or fingerlike projections**, develop out of the trophoblast and extend into the blood-filled spaces of the endometrium.
- These villi are vascular processes that obtain oxygen and nutrients from the maternal bloodstream and dispose of carbon dioxide and waste products into the maternal circulation.





- After implantation, the endometrium is called the **decidua**.
- The portion directly under the blastocyst, where the chorionic villi tap into the maternal blood vessels, is the **decidua basalis**.
- The portion covering the blastocyst is the **decidua capsularis ,** and the portion lining the rest of the uterus is the **decidua vera.**



Embryo and Fetus Development

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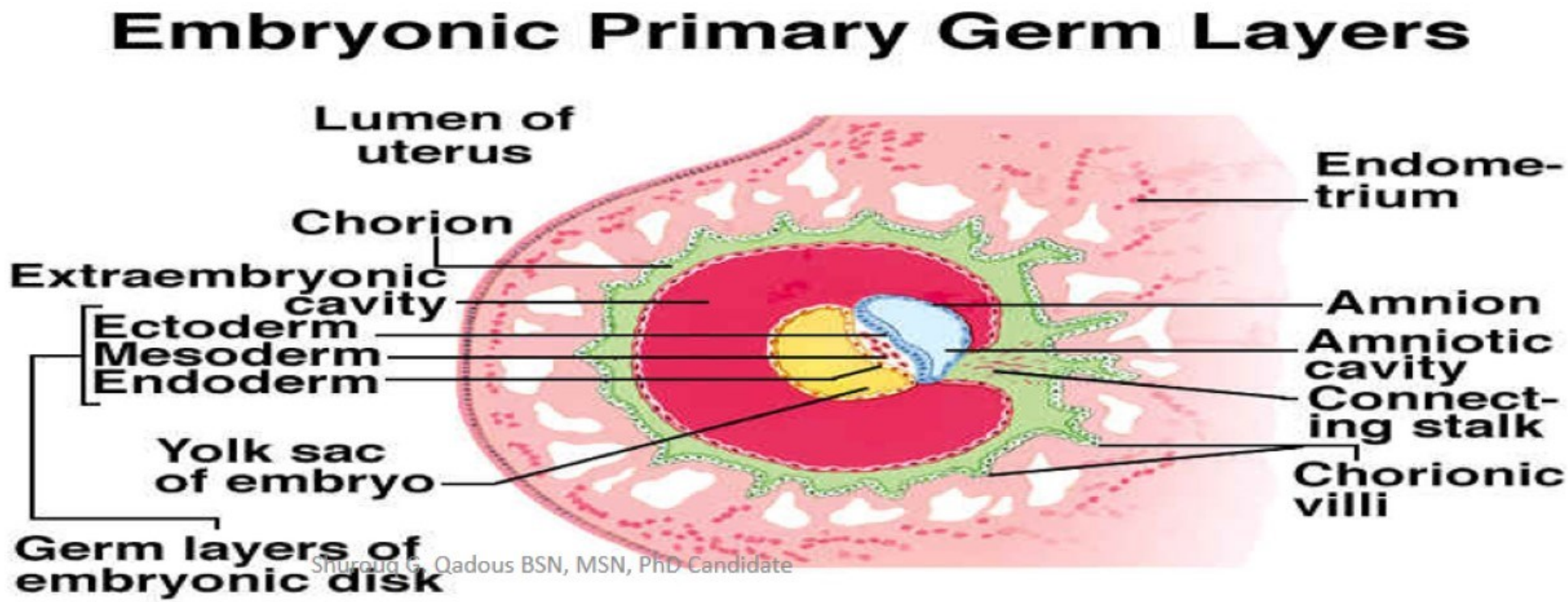
The embryo and fetus

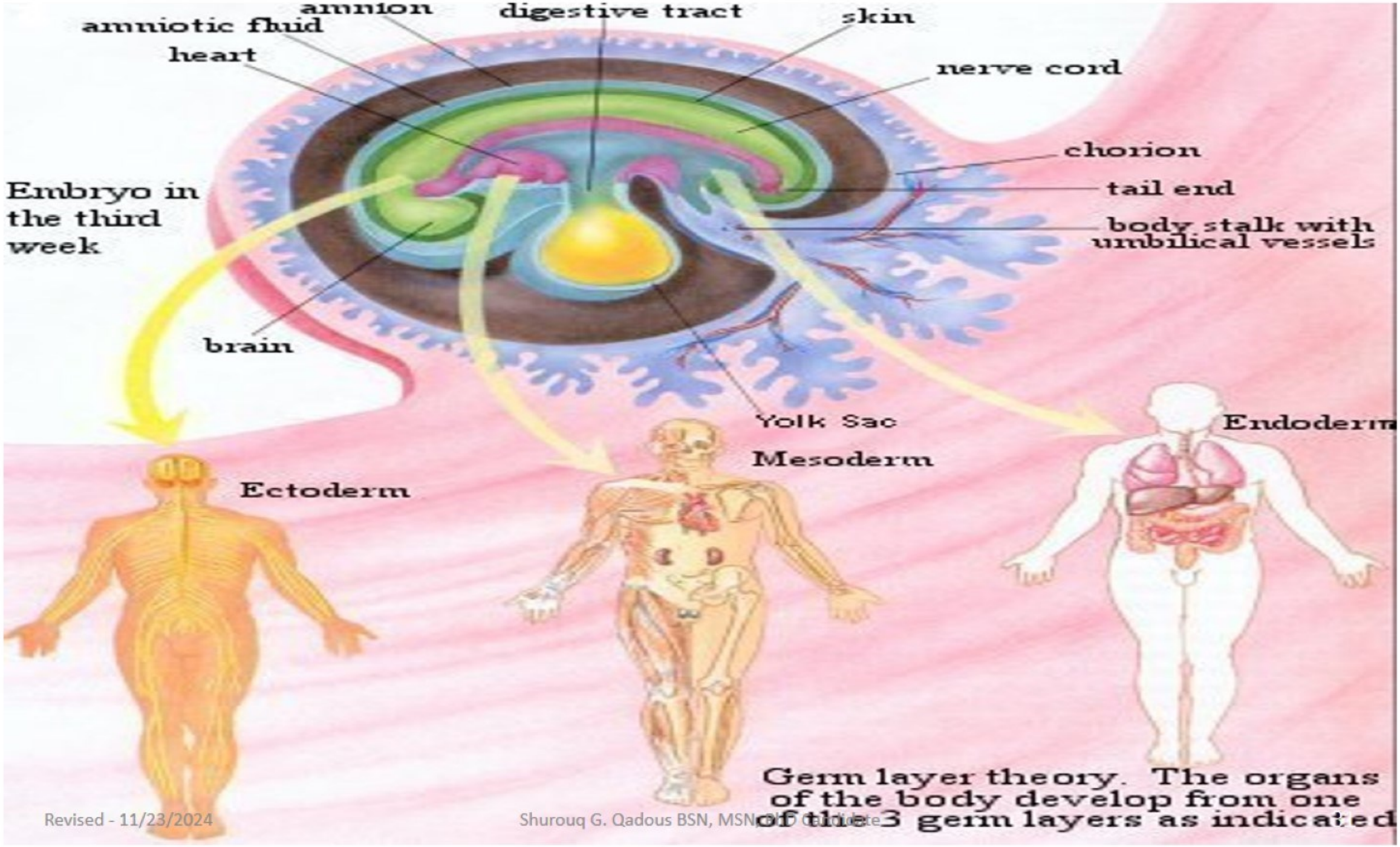
- Pregnancy lasts approximately 10 lunar months, 9 calendar months, 40 weeks (about 9 months), or 280 days (about 9 months).
- Length of pregnancy is computed from the first day of the last menstrual period (LMP) until the day of birth.
- Conception occurs approx. 2 weeks after the day of the LMP.
- Intrauterine development is divided into three stages: **ovum or preembryonic, embryo, and fetus.**

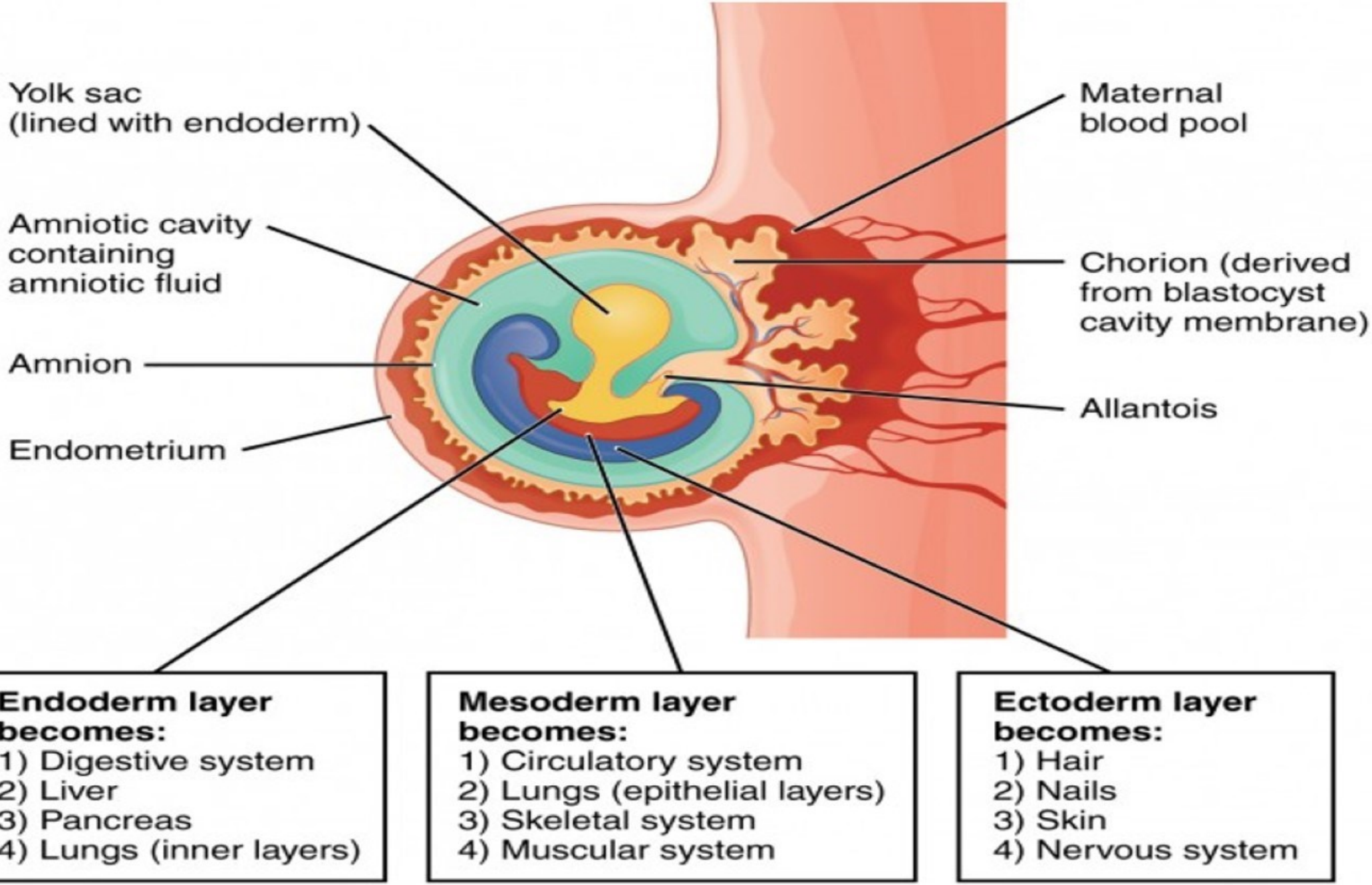
Primary Germ layers

- During the 3 week after conception the embryonic disk differentiates into 3 primary germ layer: ectoderm, mesoderm, and endoderm (entoderm).
- All tissues and organs of the embryo develop from these three layers.



- **The ectoderm, or upper layer of the embryonic disk**, gives rise to the epidermis, glands (anterior pituitary, cutaneous, and mammary), nails and hair, central and peripheral nervous systems, lens of the eye, tooth enamel, and floor of the amniotic cavity.
- **The mesoderm, or middle layer,** develops into the bones and teeth, muscles (skeletal, smooth, and cardiac), dermis and connective tissue, cardiovascular system and spleen, and urogenital system.
- **The endoderm, or lower layer,** gives rise to the epithelium lining the respiratory tract and digestive tract, including the oropharynx, liver and pancreas, urethra, bladder, and vagina.


amnion
amniotic fluid
heart
digestive tract
skin
nerve cord
chorion
tail end
body stalk with
umbilical vessels
Embryo in
the third
week
brain
Yolk Sac
Ectoderm
Mesoderm
Endoderm
Gem layer theory. The organs
of the body develop from one
of the 3 germ layers as indicated



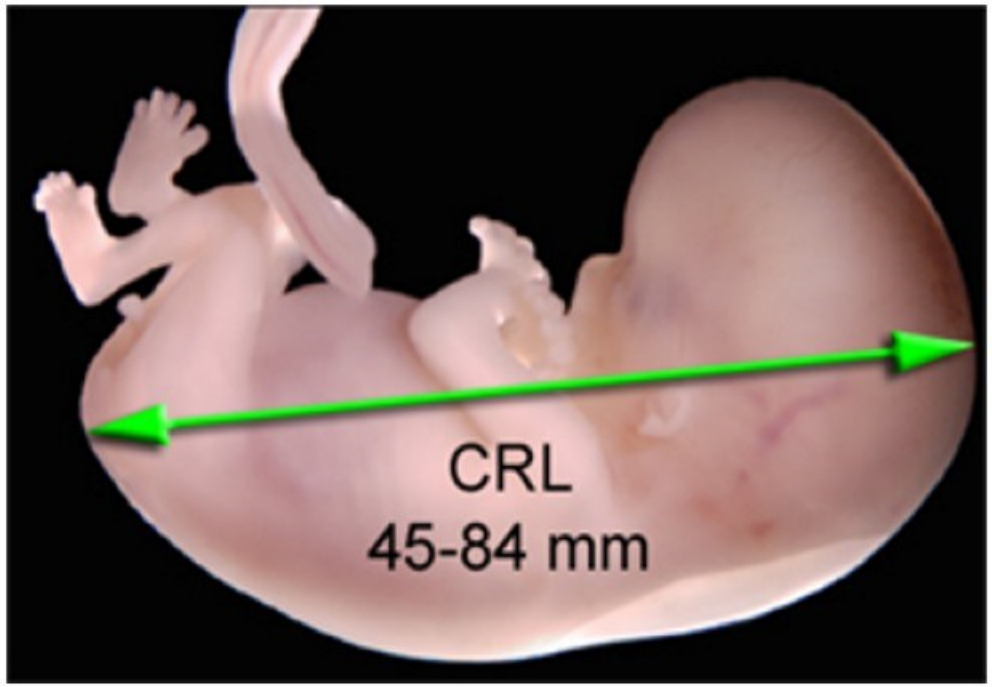
Endoderm layer becomes:
1) Digestive system
2) Liver
3) Pancreas
4) Lungs (inner layers)

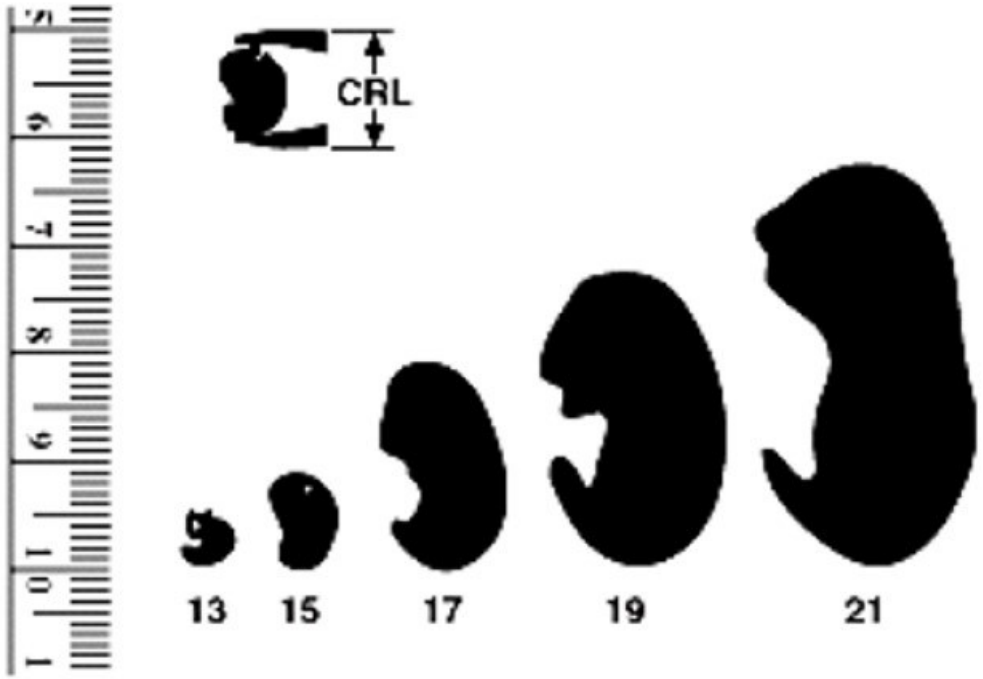
Mesoderm layer becomes:
1) Circulatory system
2) Lungs (epithelial layers)
3) Skeletal system
4) Muscular system

Ectoderm layer becomes:
1) Hair
2) Nails
3) Skin
4) Nervous system

Development of the embryo

- The stage of the embryo lasts from **day 15 until approximately 8 weeks after conception**, when the embryo measures approximately **3cm from crown to rump.**





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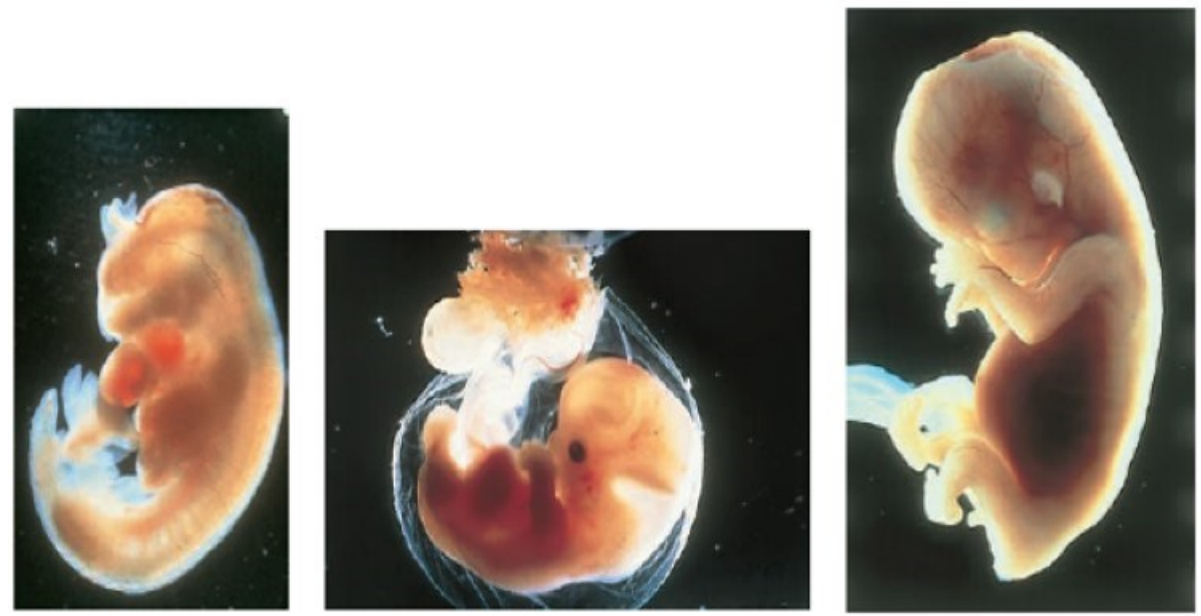
- The embryonic stage is the most critical time in the development of the organ systems and the main external features.
- Developing areas with rapid cell division are the most vulnerable to malformation by environmental teratogens.
- At the end of the 8 week all organ systems and external structures are present, and the embryo is unmistakably human.



4 weeks

8 weeks

12 weeks

16 weeks

20 weeks

25 weeks

28 weeks

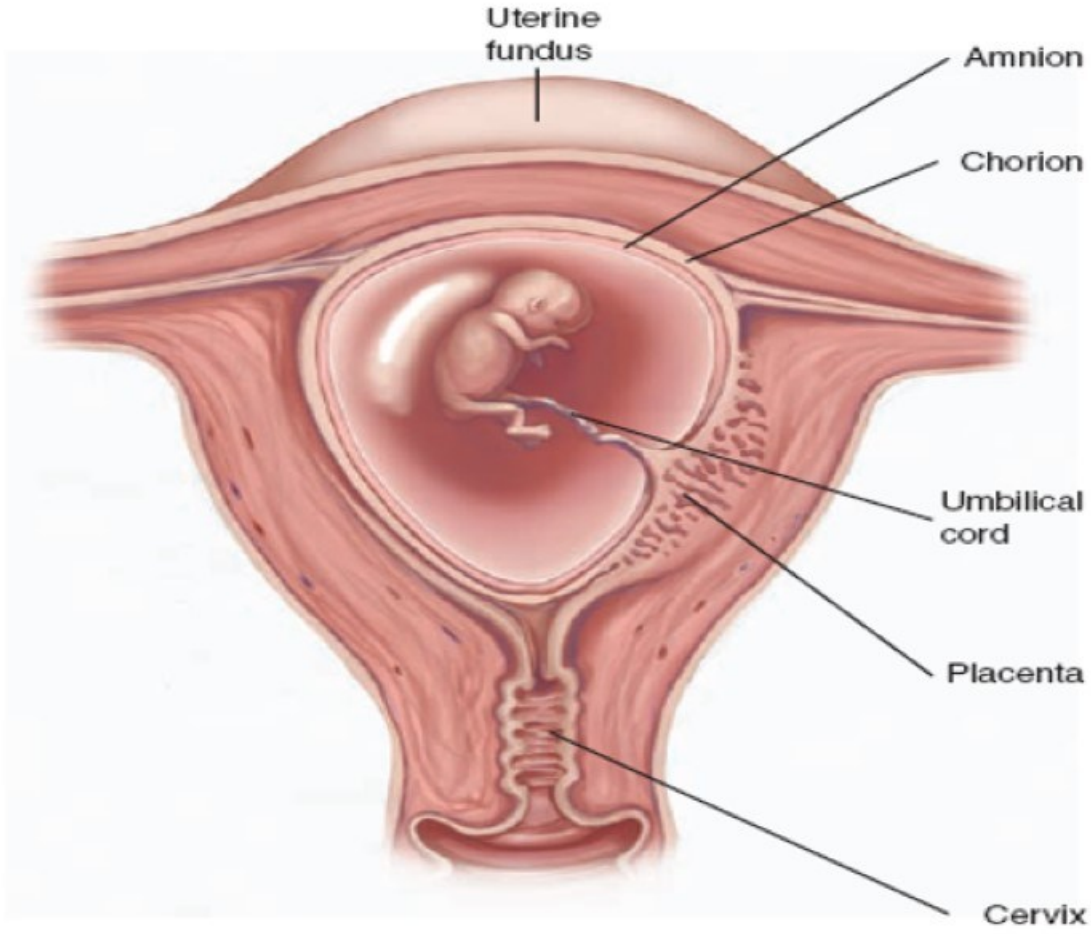
32 weeks

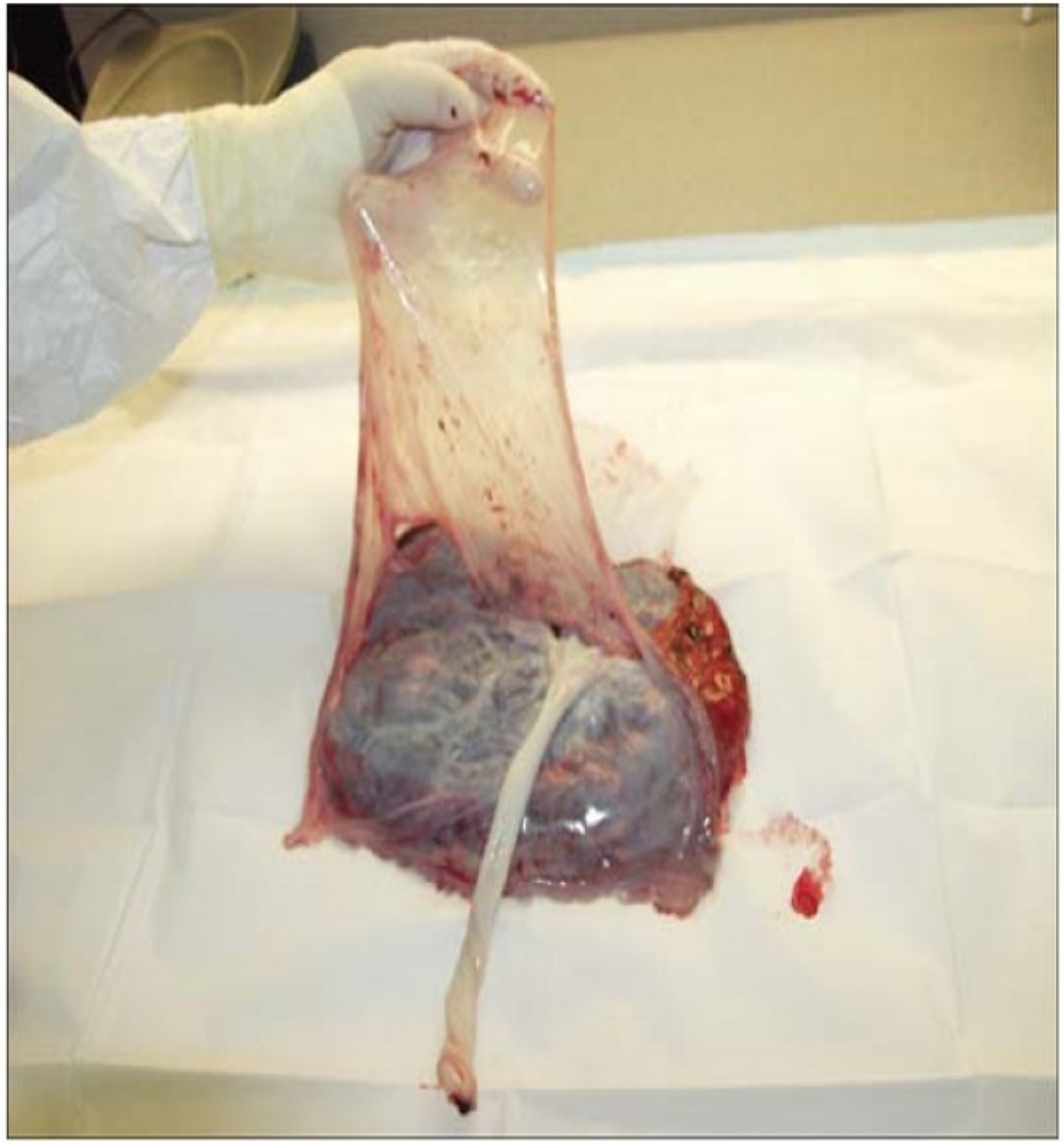
37 weeks

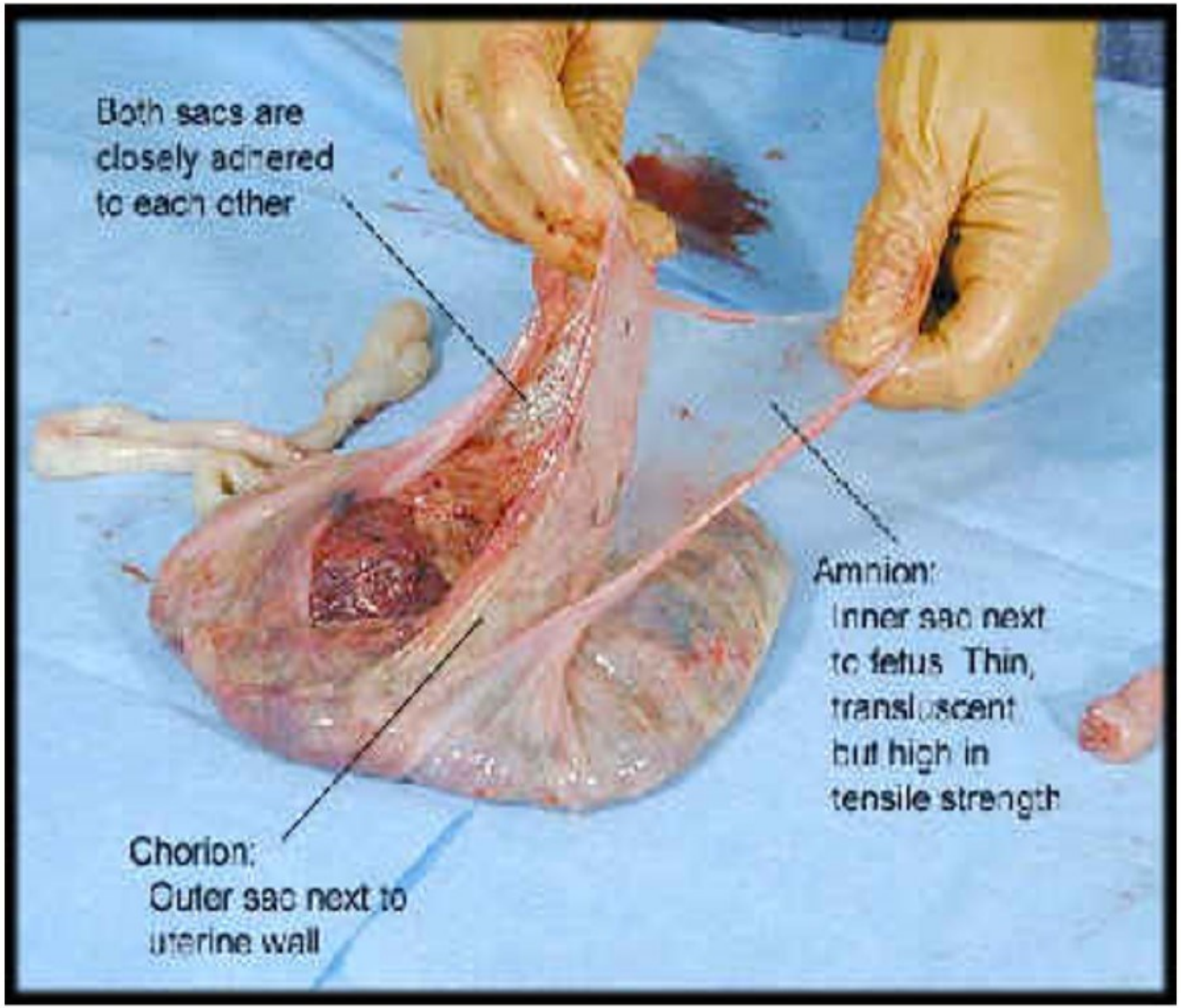
Membranes

- At the time of implantation, two **fetal membranes** that will surround the developing embryo begin to form.
- The **chorion** develops from the trophoblast and contains the chorionic villi on its surface.
- The chorion becomes the covering of the fetal side of the placenta. It contains the major umbilical blood vessels that branch out over the surface of the placenta.

- The inner cell membrane, the **amnion**, develops from the interior cells of the blastocyst.
- The cavity that develops between this inner cell mass and the outer layer of cells (trophoblast) is the amniotic cavity.
- The developing embryo draws the amnion around itself to form a fluid – filled sac.
- The amnion becomes the covering of the umbilical cord and covers the chorion on the fetal surface of the placenta.


Uterine fundus
Amnion
Chorion
Umbilical cord
Placenta
Cervix




Both sacs are closely adhered to each other
Amnion:
Inner sac next to fetus Thin, translucent but high in tensile strength
Chorion:
Outer sac next to uterine wall

Amniotic fluid

- At first the amniotic cavity derives its fluid by diffusion from the maternal blood.
- **The amount of fluid increases weekly, 800 to 1200 ml of transparent liquid are normally present at term (less than 300ml (oligohydramnios), more than 2L (hydramnios).**
- The volume of amniotic fluid changes constantly.
- The fetus swallow fluid, and fluid flows into and out of the fetal lungs. the fetus urinates into the fluid, greatly increasing its volume.

Functions of amniotic fluid:-

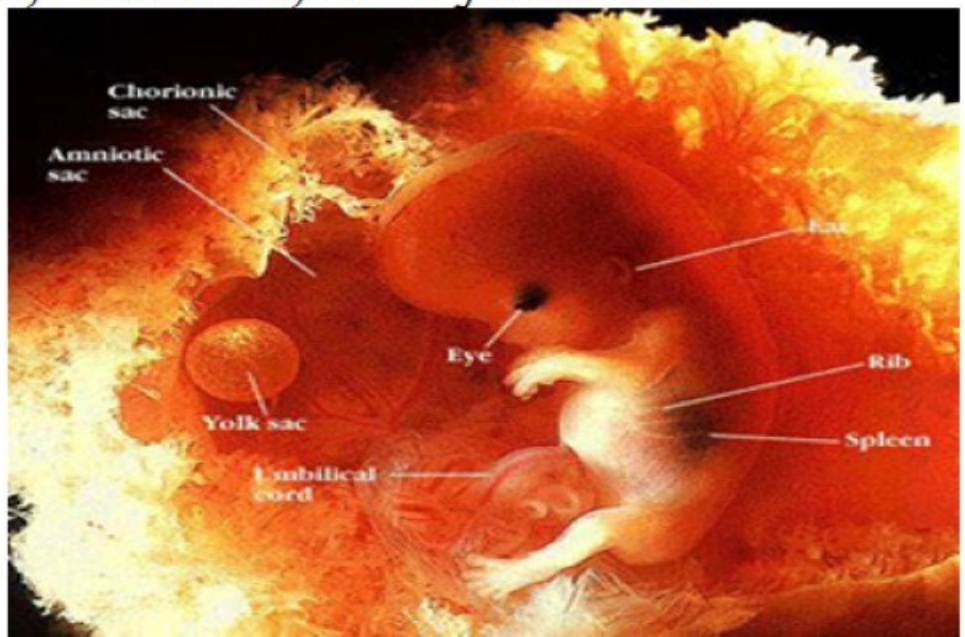
- Maintain a constant body temperature
- Serves as source of oral fluid and as repository for waste.
- Cushing fetus from outside trauma
- Allows freedom of movement for musculoskeletal development.
- The fluid keeps the embryo from tangling with the membranes, facilitating symmetric growth of the fetus.

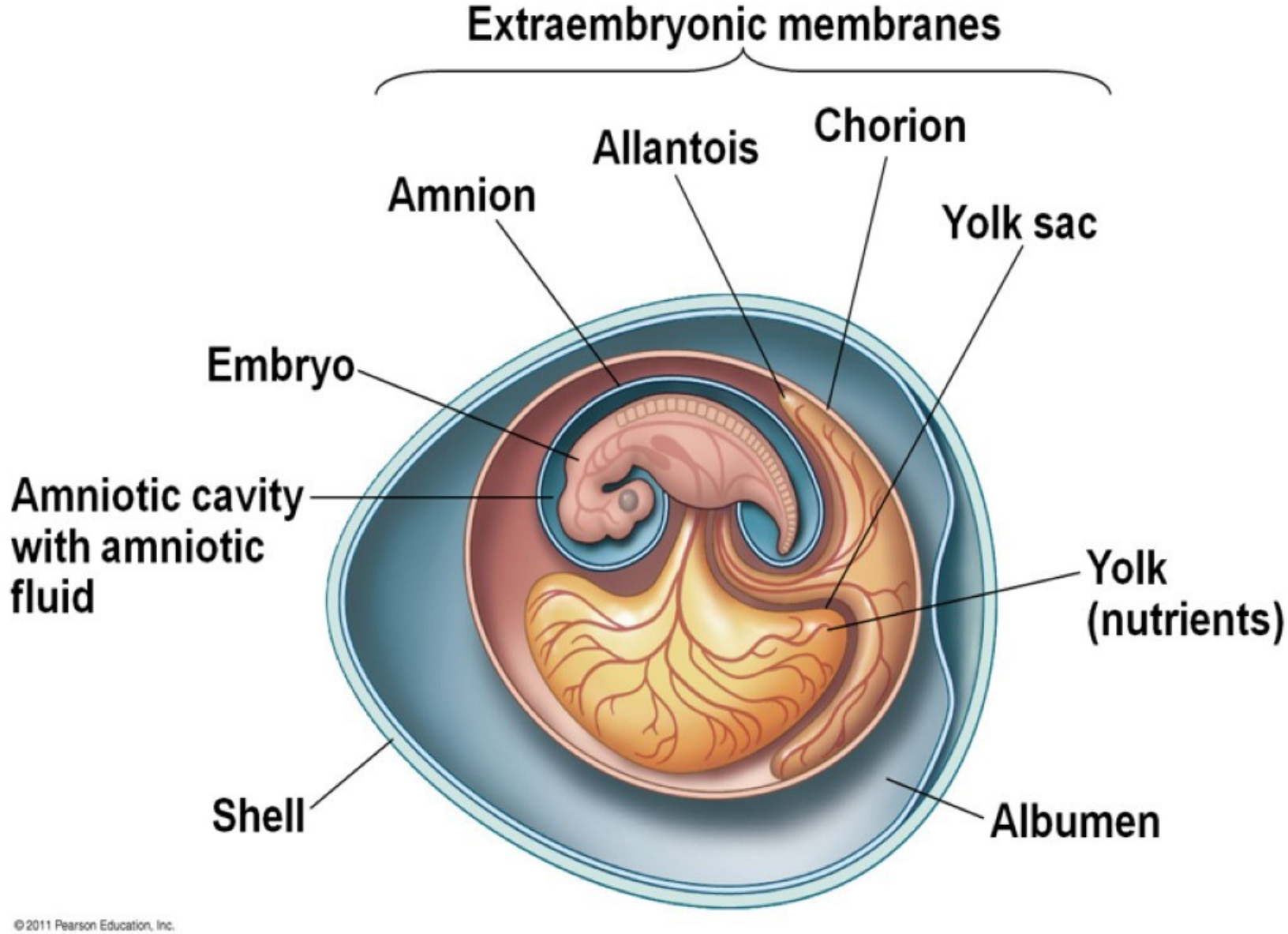
- Amniotic fluid contains albumin, urea, uric acid, creatinine, bilirubin, fructose, fat, leukocytes, proteins, epithelial cells, enzymes, lanugo hair, lecithin, sphingomyelin.
- **Study of fetal cells in amniotic fluid through amniocentesis yields much information about the fetus.**

✓Genetic studies (karyotyping) provide knowledge about the sex of the fetus and the number and the structure of chromosomes.

✓(L/S) lecithin / sphingomyelin ratio determine maturity of the fetus.

- At the same time the amniotic cavity and amnion are forming another blastocyst cavity forms on the other side of the developing embryonic disk. This cavity becomes surrounded by a membrane, forming the yolk sac.
- Yolk sac aids in transferring maternal nutrients and oxygen, which have diffused through the chorion, to the embryo. **Blood cell and plasma are manufactured in the yolk sac during the second and third weeks.**
- At the end of third week, the primitive heart begins to beat and circulate the blood through the embryo, connecting stalk, chorion, and yolk sac.




Extraembryonic membranes
Allantois
Chorion
Amnion
Yolk sac
Embryo
Amniotic cavity with amniotic fluid
Yolk (nutrients)
Shell
Albumen
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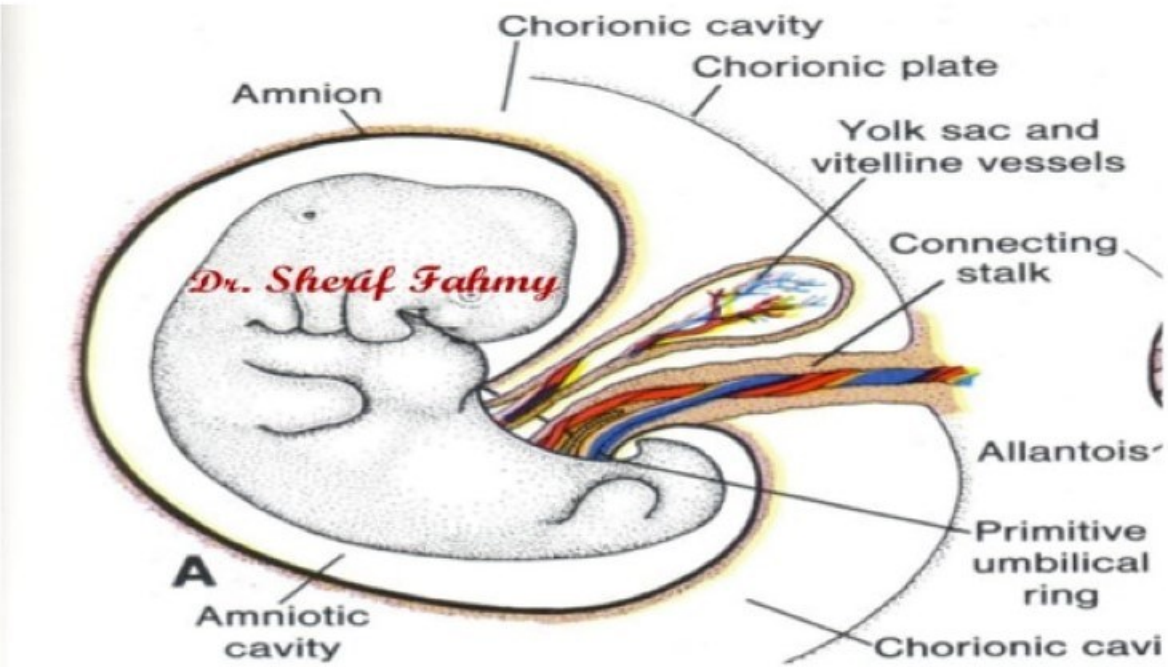
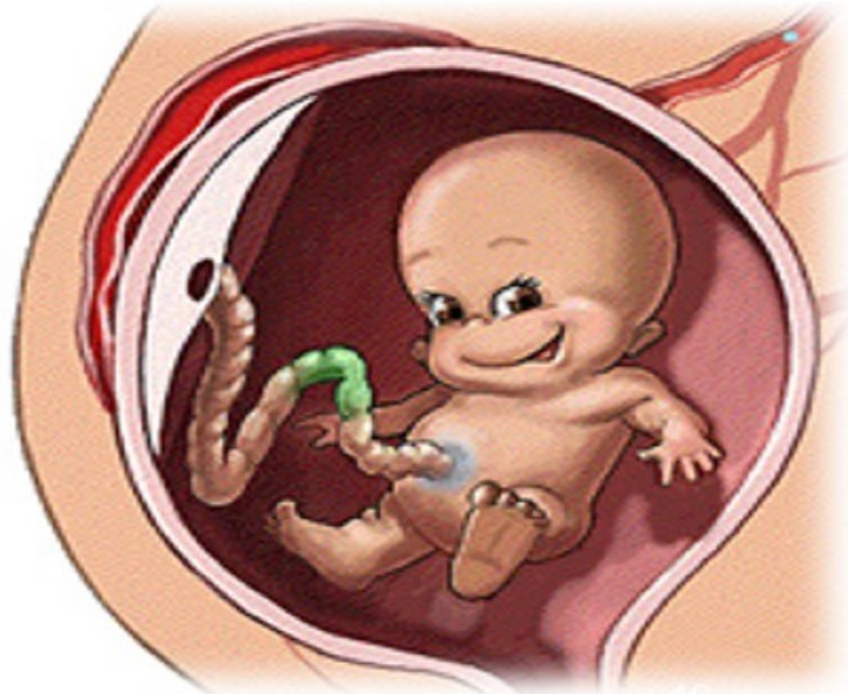
Umbilical cord

- During the fifth week, the embryo has curved inward on itself from both ends (bringing the connecting stalk to the ventral side of the embryo).
- The connecting stalk becomes compressed from both sides by the amnion forms the narrower umbilical cord.





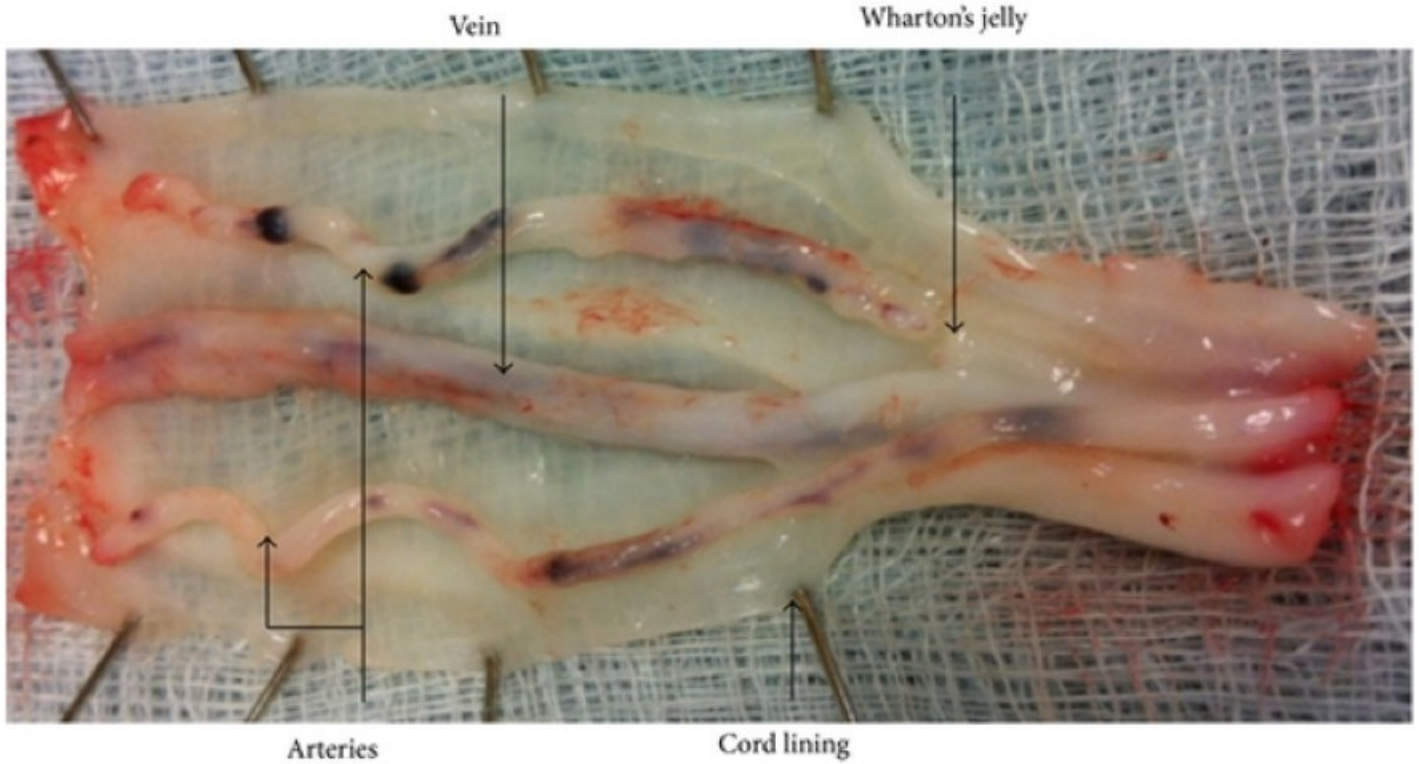
Re

- Two arteries carry blood to the chorionic villi from the embryo, and one vein returns blood to the embryo.
- Approx. 1% of umbilical cords contain only two vessels (associated with congenital malformation).
- The cord rapidly increases in length. At term, the cord is 2cm in diameter and ranges from 30 to 90 cm in length (with an average of 55cm).

- True knot is rare.

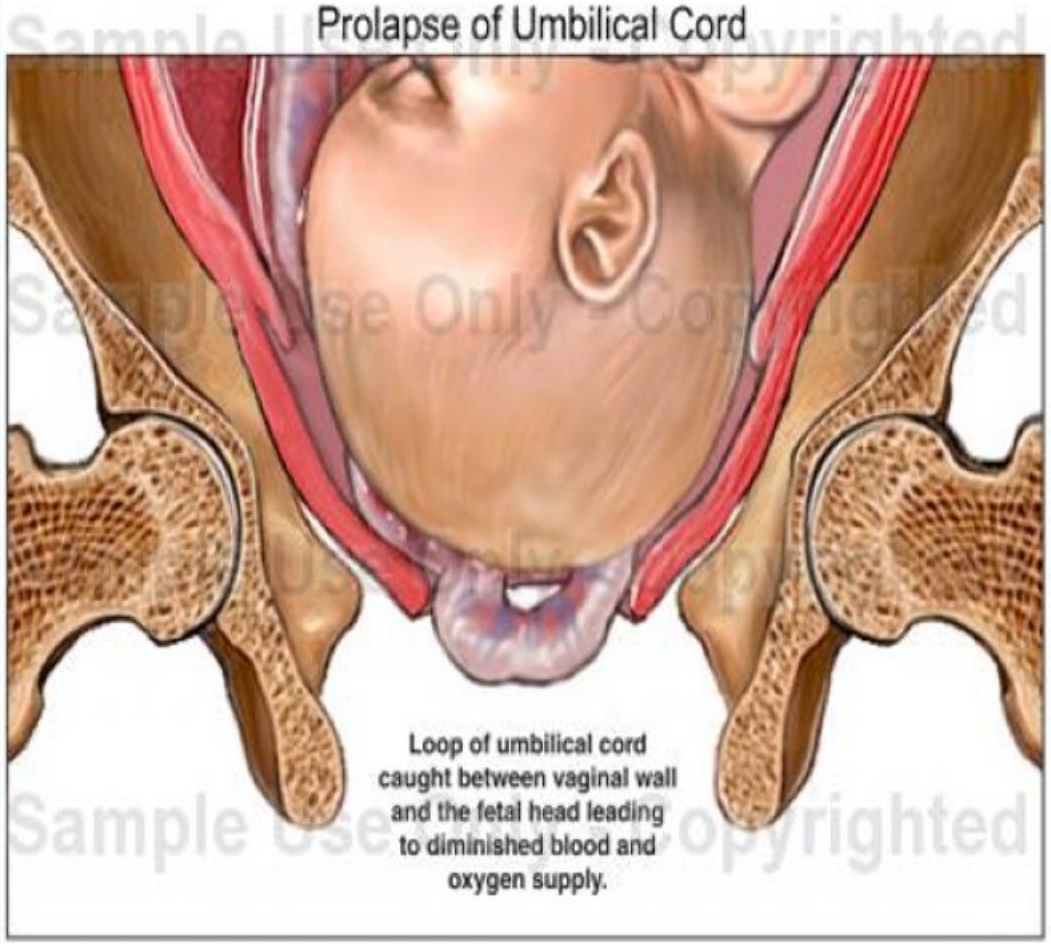
- False knot occur as fold or Kinks in the cord.

- Connective tissue called ***Wharton's jelly*** prevents compression of the blood vessels and ensures continued nourishment of the embryo and fetus.



- When the cord is wrapped around the fetal neck, it is called **a nuchal cord.**

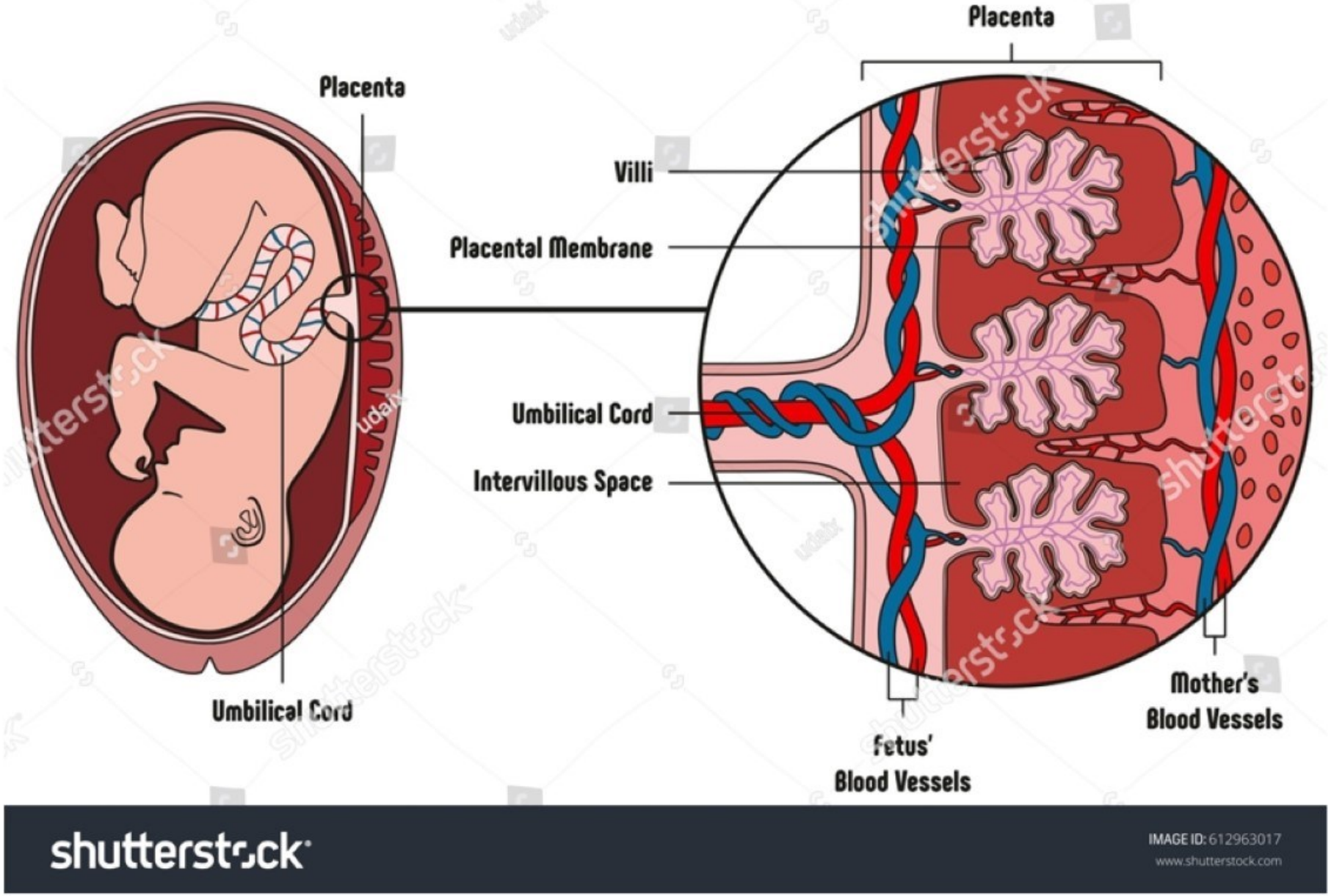
- Umbilical cord is usually located centrally.
- A peripheral location is less common and is known as a **battledore placenta.**



Placenta

Structure

- The placenta begins to form at implantation.
- During the third week after conception the trophoblast cells of the chorionic villi continue to invade the decidua basalis. As the uterine capillaries are tapped, the endometrial spiral arteries fill with maternal blood.
- Chorionic villi grow into the spaces with **2 layers of cells: the outer syncytium and the inner cytotrophoblast.**
- A third layer develops into anchoring septa, dividing the projecting decidua into separate called **cotyledons**.
- In each of the 15 to 20 cotyledons, the chorionic villi branch out , and a complex system of fetal blood vessels forms.


Placenta
Placenta
Villi
Placental Membrane
Umbilical Cord
Intervillous Space
Umbilical Cord
Mother's
Blood Vessels
Fetus'
Blood Vessels
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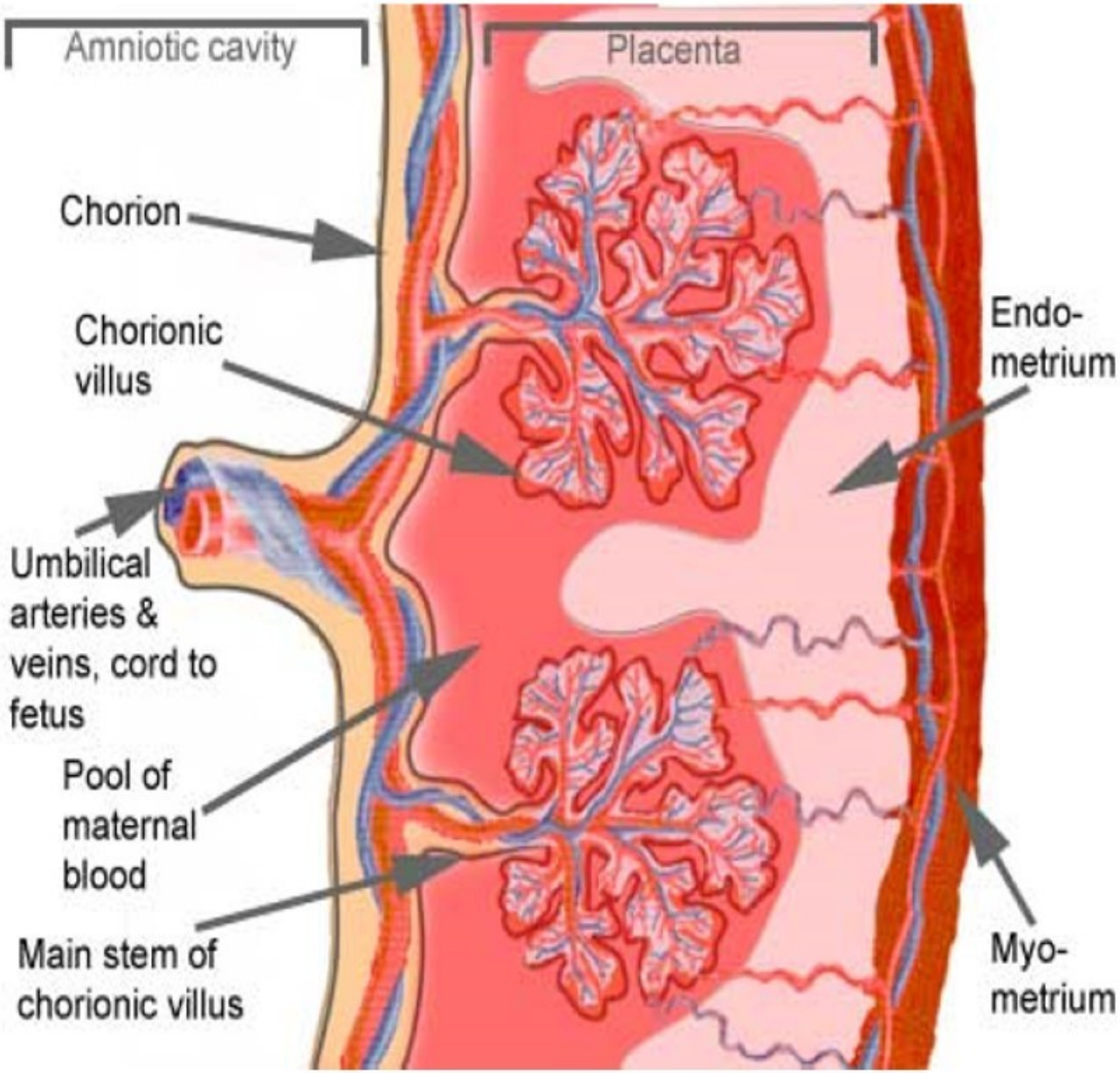
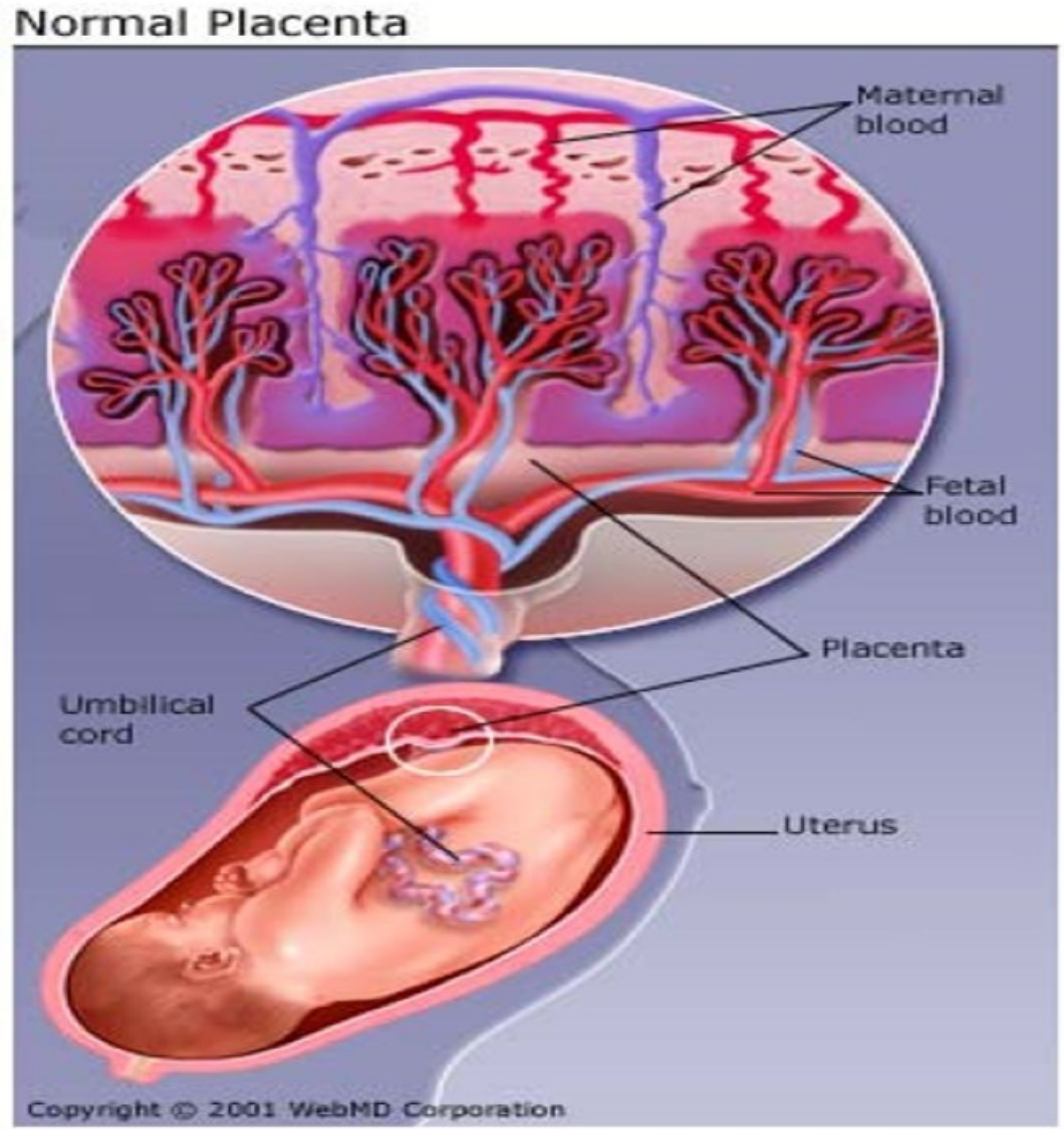

Amniotic cavity
Placenta
Chorion
Chorionic villus
Umbilical arteries & veins, cord to fetus
Pool of maternal blood
Main stem of chorionic villus
Endo-metrium
Myo-metrium


Normal Placenta
Maternal blood
Fetal blood
Placenta
Umbilical cord
Uterus
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- By the end of the third week, embryonic blood is circulating between the embryo and the chorionic villi.
- By the fifth month only the single of syncytium is left between the maternal blood and the fetal capillaries. The syncytium is the functional layer of the placenta.
- By the eighth week, genetic testing may be done by a sample of chorionic villi (however limb defects have been associated with CVS done before 10 weeks).
- The structure of the placenta is complete by the 12 week.
- The placenta continues to grow wider until 20 weeks, when it covers about half of the uterine surface. It then continues to grow thicker.

Functions

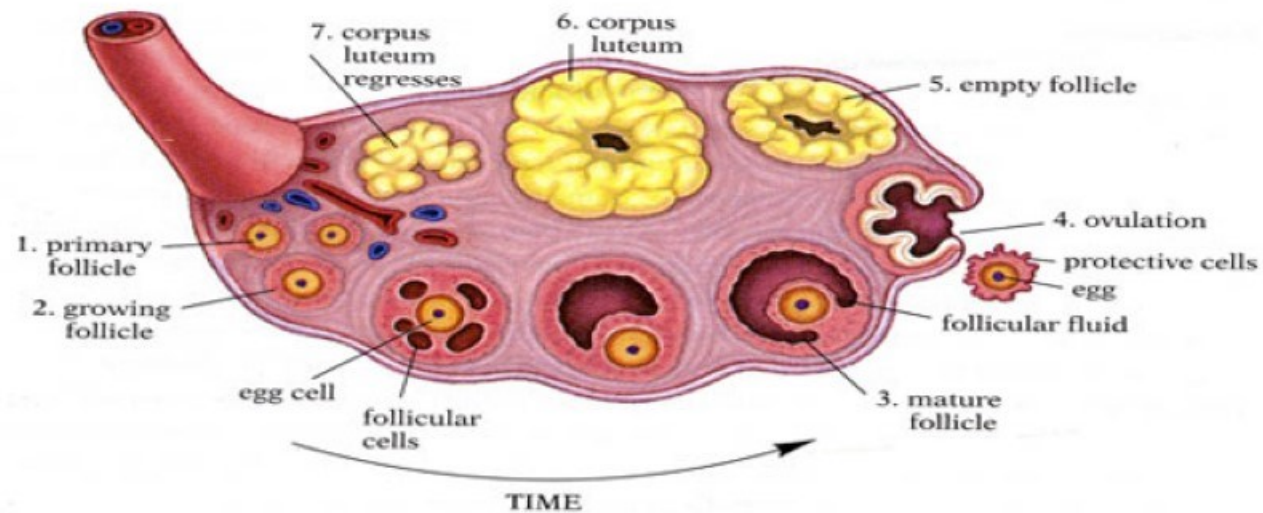
- Early functions of the placenta is as an **endocrine gland** that produce 4 hormones, and these hormones are produced in the syncytium.

1. Human chorionic gonadotropin (hCG) (can be detected in the maternal serum by 7 to 10 days after conception, shortly after implantation).

✓This hormone is basis for pregnancy tests.

✓hCG preserve the function of the ovarian corpus luteum, ensuring a continued supply of estrogen and progesterone level needed to maintain the pregnancy.

✓hCG reaches its maximum level at 50 to 70 days then begins to decrease.



2. hCS or hPL (human chorionic somatomammotropin or human placental lactogen).

- ✓This substance is similar growth hormone and stimulates maternal metabolism to supply needed nutrients for fetal growth.
- ✓This hormone increase the resistance to insulin, facilitates glucose transport across the placental membrane, and stimulates breast development to prepare for lactation.

3. Steroid hormone (progesterone, estrogen)

✓ **Progesterone** maintain the endometrium, decrease the contractility of the uterus, stimulates development of breast alveoli and maternal metabolism.

✓The major **estrogen** secreted by the placenta is estriol, whereas the ovaries produce mostly estradiol. Measuring estriol levels is a clinical assay for placental functioning.

- Estrogen stimulates the growth of the uterus and uteroplacental blood flow.
- It causes proliferation of the breast glandular tissue and stimulate myometrial contractility.
- One theory for the cause of the onset of labor is the decrease in circulating levels of progesterone and the increased level of estrogen.

- Metabolic functions of the placenta are respiration (placenta act as lung for the fetus), nutrition, excretion (metabolic waste products of the fetus cross the placenta membrane), and storage (carbohydrates, proteins, calcium, and iron) are stored in the placenta for ready access to meet fetal needs.
- Water, inorganic salts, carbohydrates, proteins, fat, and vitamins pass the maternal blood supply across the placental membrane into the fetal blood, supplying nutrition.
- Maternal glucose moves into fetal circulation by active transport.

- Many viruses can cross the placenta membrane and infect the fetus.
- Some bacteria and protozoa first infect the placenta and then infect the fetus.
- Drugs can cross the placental membrane and may harm the fetus.
- Caffeine, alcohol, nicotine, carbon monoxide, cocaine readily cross the placenta.

Fetal maturation

- The stage of the **fetus** lasts from 9 weeks (when the embryo becomes recognizable as human being) until the pregnancy ends.
- The fetus is less vulnerable to teratogens, except for those that affect central nervous system functioning.
- Viability refers to the capability of the fetus to survive outside the uterus.
- In the past the earliest age at which fetal survival could be expected was 28 weeks after conception.
- Modern technology and advances in maternal and neonatal care, viability is now possible approx. 20 weeks after conception (22 weeks since LMP, fetal weight of 500g or more).

1. Respiratory system

- The development of the respiratory tract begins in week 4 and continues through week 17 with formation of the larynx, trachea, bronchi, and lung buds.

- Between 24 weeks and term birth, more alveoli form. Specialized alveolar cells, type 1 and type 2 cells, secrete pulmonary surfactants.

- After 32 weeks, sufficient surfactant is present to provide infants with good chance of survival.

Pulmonary surfactants (surface active phospholipids) the detection of the presence of pulmonary surfactant in amniotic fluid has been used to determine the degree of fetal lung maturity.

- **Lecithin** is the most critical alveolar surfactant required for postnatal lung expansion.
- It is detectable at approx. 21 weeks and increases in amount after week 24.
- Another pulmonary phospholipid, **sphingomyelin**, remains constant in amount.
- *L/S ratio reaches 2:1 the lung are consider to be mature, which occurs at approx. 35 weeks of gestation.*

PRETERM LUNGS

24–35 Weeks
Gestational Age

TERM LUNGS

36 Weeks Gestational
Age to 3 Years of Age

Adapted from Moore and Persaud 2008.[1]

Babies born early have lungs that are smaller and less developed at birth than those of full-term babies.

- Gestational diabetes and chronic glomerulonephritis can retard fetal lung maturity.
- Fetal respiratory movements have been seen on U/S as early as the 11 week. These movements may aid in development of the chest wall muscles and regulate lung fluid volume.
- The fetal lungs produce fluid that expands the air spaces in the lungs.
- The fluid drains into the amniotic fluid or is swallowed by the fetus.
- Before birth, secretion of lung fluid decreases. The normal birth process squeezes out approx. one third of the fluid. (C/S …..?).
- The fluid remaining in the lungs at birth is usually reabsorbed into the infant's blood stream within 2 hours of birth.

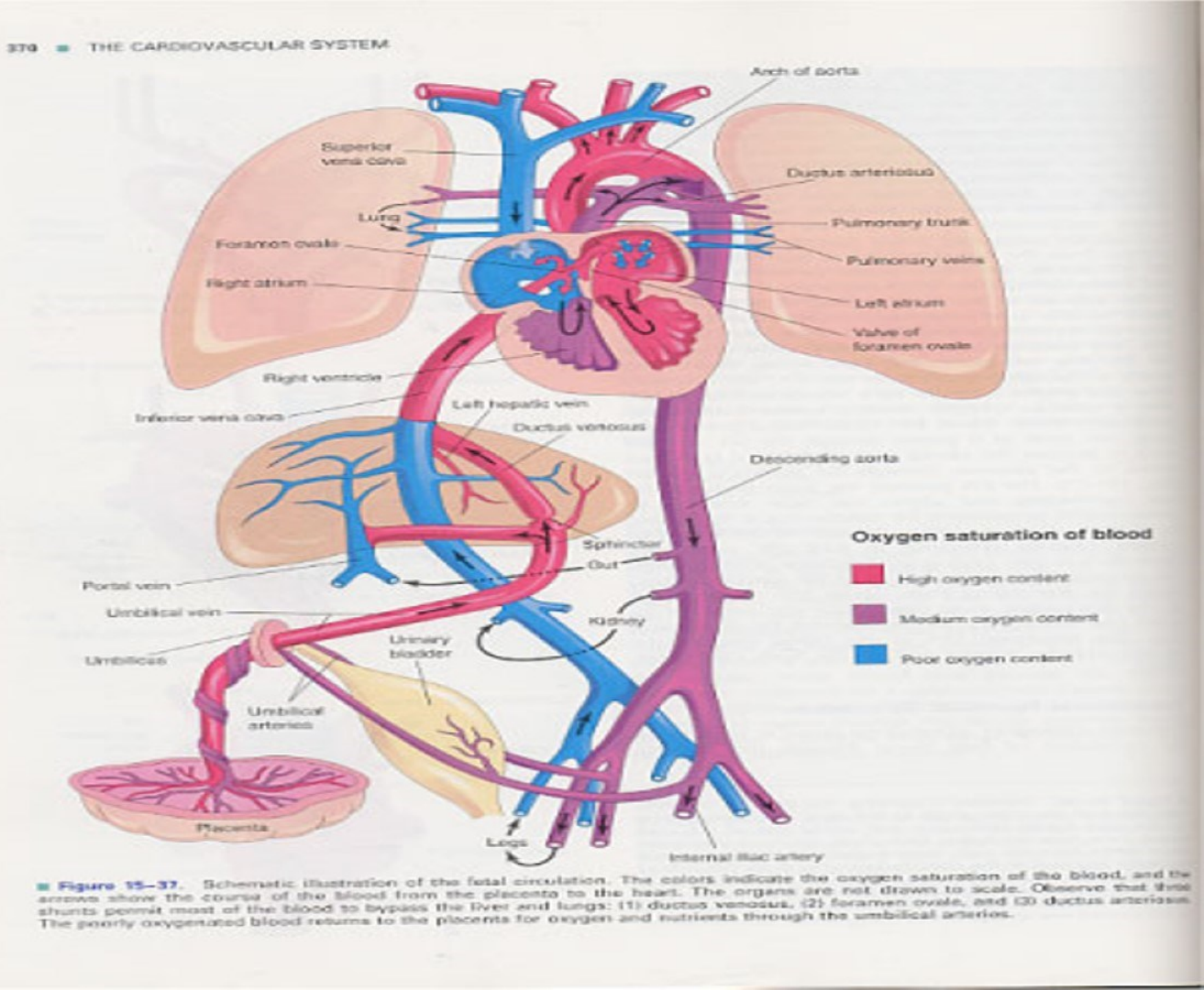
2. Fetal circulatory system

- The cardiovascular system is the first organ system to function in the developing human.
- Blood vessel and blood cell formation begins in the third week and supplies the embyro with oxygen and nutrients from mother.
- During the fourth and fifth weeks the heart develops into a four chambered organ.
- By the end of the embryonic stage, the heart is developmentally complete.

Three shunts are present in fetal life:

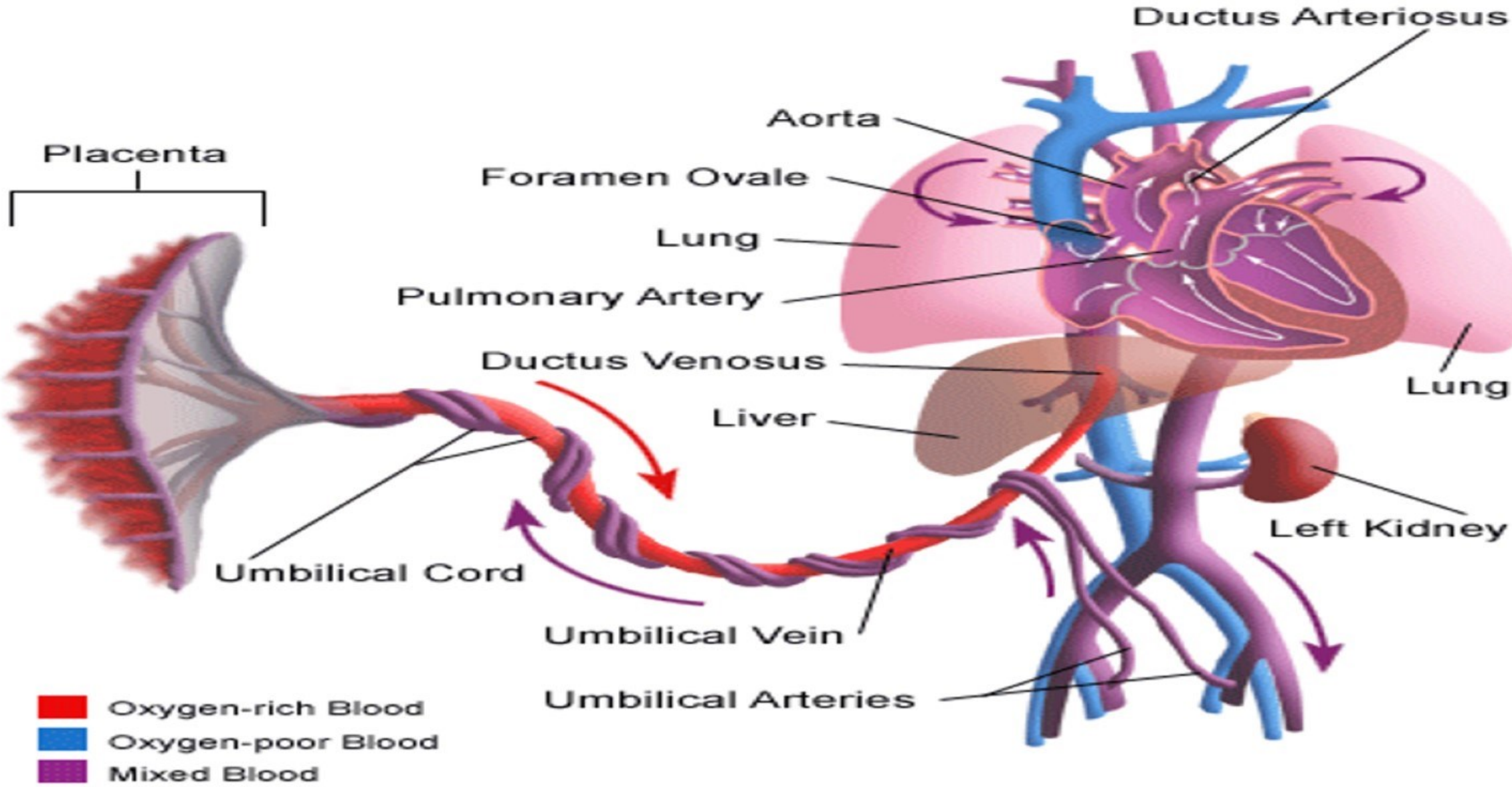
1. Ductus venosus: connects the umbilical vein to the inferior vena cava
2. Ductus arteriosus: connects the main pulmonary artery to the aorta
3. Foramen ovale: anatomic opening between the right and left atrium.

Revised - 11/23/2024



- Oxygen – rich blood from the placenta flows rapidly through the umbilical vein into the fetal abdomen when the umbilical vein reaches the liver it divides into two branches. **One branch** circulates some oxygenated blood through the liver.
- Most of the blood passes through the **ductus venosus** into the inferior vena cava. There it mixes with the deoxygenated blood from the fetal legs and abdomen on its way to the Rt. atrium.
- Most of this blood passes straight through the right atrium and through the **foramen ovale**, an opening into the left atrium. There it mixes with the small amount of deoxygenated blood returning from the fetal lungs through the pulmonary veins.

Fetal Circulation



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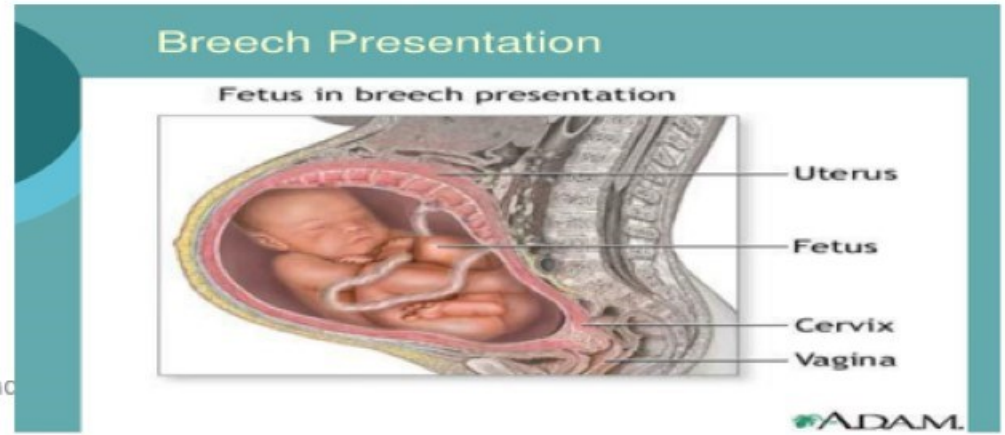
- The bloods flows into the left ventricle and is squeezed out into the aorta, where the arteries supplying the heart, head, neck, and arms receive most of the oxygen – rich blood.
- Deoxygenated blood returning from the head and arms enters the right atrium through the superior vena cava. The blood is directed downward into the right ventricle where it is squeezed into the pulmonary artery.
- A small amount of blood circulates through the resistant lung tissue, but the majority follows the path with less resistance through the **ductus arteriosus** into the aorta, distal to the point of exit of the arteries supplying the head and arms with oxygenated blood.

3. Hepatic system

- Hematopoiesis begins during the sixth week and requires that the liver be large.
- The embryonic liver is prominent, occupying most of the abdominal cavity.
- Glycogen is stored in the fetal liver beginning at week 9 or 10, at term stores are twice those of the adult. Glycogen is the major source of energy for the fetus and for the neonate stressed by in utero hypoxia, extrauterine loss of maternal glucose supply, the work of breathing, or cold stress.
- **Iron** is stored in the fetal liver. If maternal intake is sufficient, the fetus can store enough iron to last for 5 months after birth.

4. Gastrointestinal system (GIS)

- Fetus swallow amniotic fluid beginning in the fifth month.
- Gastric emptying and intestinal peristalsis occur as the fetus near term, fetal waste products accumulate in the intestines as dark green to black, tarry meconium.
- Normally newborn pass meconium within 24 hours of birth.
- Sometimes, with a breech presentation or fetal hypoxia, meconium is passed in utero into the amniotic fluid.
- GIS is mature by 36 weeks. Digestive enzymes (except pancreatic amylase and lipase) are present in sufficient quantity to facilitate digestion.



5. Renal system

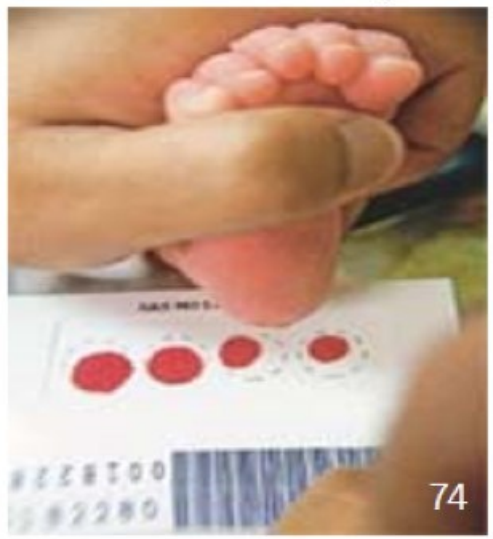
- Kidneys form during the fifth week and begin to function approx. 4 weeks later.
- Urine is excreted into the amniotic fluid and form a major part of the amniotic fluid volume.
- At term fetus has fully developed kidneys.
- GFR is low, and the kidneys lack the ability to concentrate urine, so this make newborn susceptible to both overhydration and dehydration.
- Most newborn void within 24 hours of birth.

6. Neurologic system

- The fetus can suck his or her thumb, swim in the amniotic fluid pool (result knot in umbilical cord)
- 16- and - 20 weeks mother feel " the baby moving" **quickening.**
- Fetuses respond to sound by 24 weeks.
- The fetus is able to distinguish taste.
- Fetus reacts to temperature changes.
- Fetus can see.
- At term, the fetal brain is approx. one fourth the size of an adult brain.

7. Endocrine system

- Thyroid gland develops along with structures in the head and neck during the third and fourth weeks.
- The secretion of thyroxine begins during the eighth week.
- Maternal thyroxin does not readily cross the placenta, therefore the fetus that does not produce thyroid hormones will be born with congenital hypothyroidism.
- If untreated, hypothyroidism can result in severe mental retardation (so PKU screening is important after birth).



- Adrenal cortex is formed during the sixth week and produces hormones by the eighth or ninth week.
- As term approaches, the fetus produces more cortisol. This hormone is believed to aid in initiation of labor by decreasing the maternal progesterone and stimulating production of prostaglandins.
- The Islets of Langerhans develop during the 12 week.
- Insulin is produced by the twentieth week.
- In infants of mothers with uncontrolled diabetes, maternal hyperglycemia produces fetal hyperglycemia, stimulating hyperinsulinemia and islet cell hyperplasia. This results in a macrosomic fetus.
- The hyperinsulinemia also blocks lung maturation, placing the neonate at risk for respiratory distress and hypoglycemia when the maternal glucose source is lost at birth.

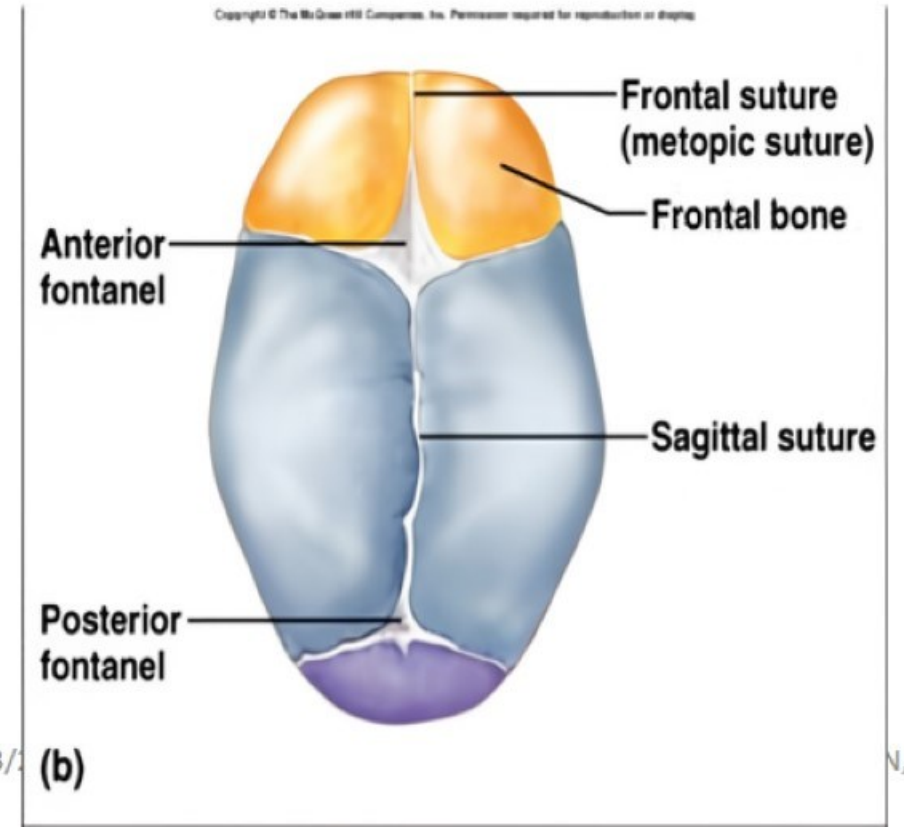
-

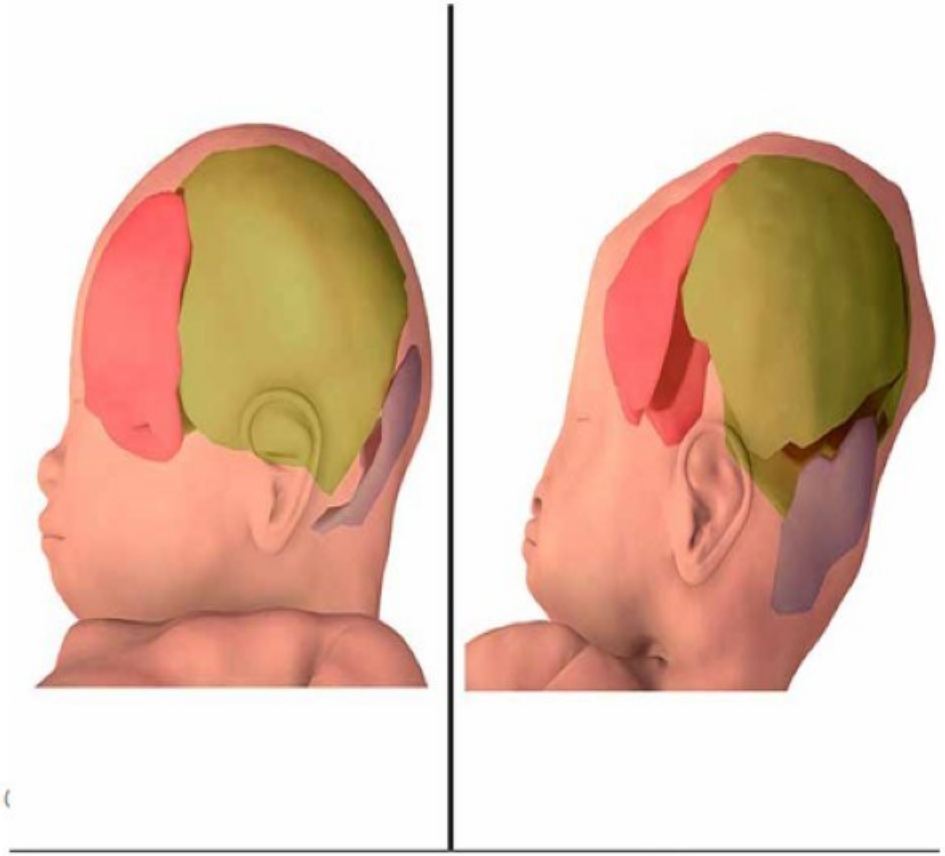
8. Reproductive system

- Sex differentiation begins in the embryo during the seventh week.
- Distinguishing characteristics appear around the ninth week and are fully differentiated by the twelfth week.
- Fetal endometrium responds to maternal hormones, and withdrawal bleeding or vaginal discharge (pseudomenstruation) may occur at birth when these hormones are lost.
- The high level of maternal estrogen also stimulates mammary engorgement and secretion of fluid (witch's milk) in newborn infants of both sexes.

9. Musculoskeletal system

- At birth, connective tissue sutures exist where the bones of the skull meet (called fontanels) are especially prominent.
- The sutures and fontanels allow the bones of the skull to mold, or move during birth, enabling the head to pass through the birth canal.





10. Integumentary system

- By the seventh week, two layers of cells have formed.
- The cells of the superficial layer are sloughed and become mixed with the sebaceous gland secretions to form the white, cheesy **vernix caseosa**, the material that protects the skin of the fetus.
- **Lanugo** very fine hairs appear first at 12 weeks on the eyebrows and upper lip.

11. Immunologic system

- During the third trimester, albumin and globulin are present in the fetus.
- The only immunological (Ig) that crosses the placenta **IgG**, provides passive acquired immunity to specific bacterial toxins.
- Fetus produces **IgM** immunoglobulins by the end of the first trimester. (produced in response to blood group antigens, gram- negative enteric organisms, and some viruses)
- **IgA** immunoglobulins are not produced by the fetus; however, colostrum contains large amounts of IgA and can provide passive immunity to the neonate who is breastfed.

Multifetal Pregnancy

Twins

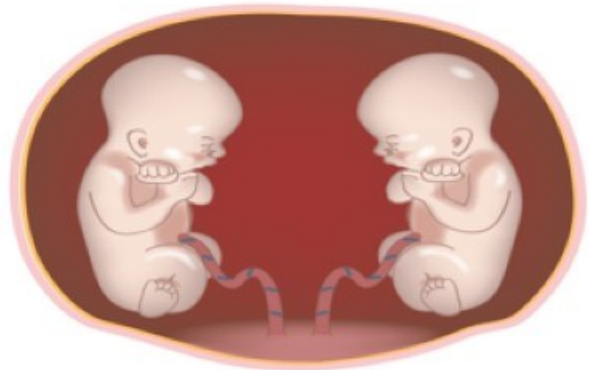
- The incidence of twinning is 1 in 43 births.
- The number of multiple births has steadily risen since 1973.
- This increase is attributed to increasing maternal age at childbirth and the use of assistive reproductive technologies.

1. Dizygotic Twins (fraternal twins)

- Two mature ova are produced in one ovarian cycle, both have the potential to be fertilized by separate sperm. This result dizygotic twins (two amnions, two chorions, and two placentas).
- These dizygotic twins may be the same sex or different sexes and are genetically no more alike than siblings born at different times.
- Dizygotic twinning increases in frequency with maternal age up to 35 years, with parity, and with the use of fertility drugs.

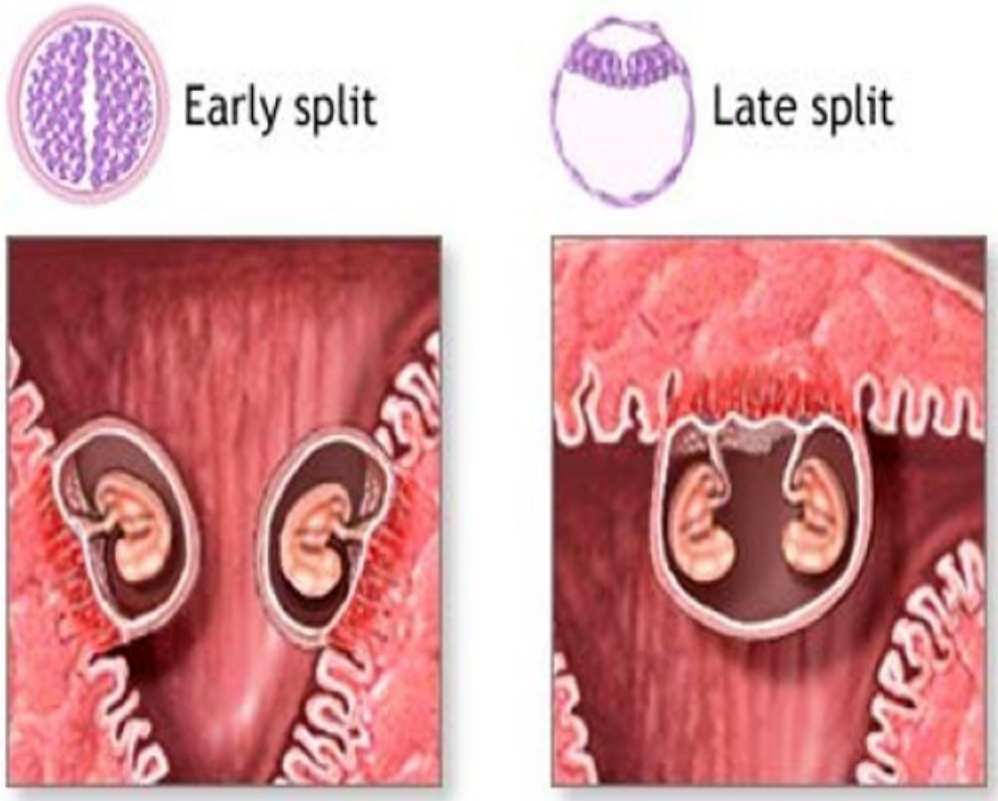
2. Monozygotic twins

- Identical or monozygotic twins develop from one fertilized ovum, which then divides.
- They are the same sex and have the same genotype.
- If division occurs soon after fertilization, two embryos, two amnions, two chorions, and two placentas.
- Most often, division occurs between 4 and 8 days after fertilization, leaving two embryos, two amnions, one chorion, and one placenta.
- Rarely, division occurs after the 8 days after fertilization. In this case, 2 embryos are within a common amnion and a common chorion with one placenta.



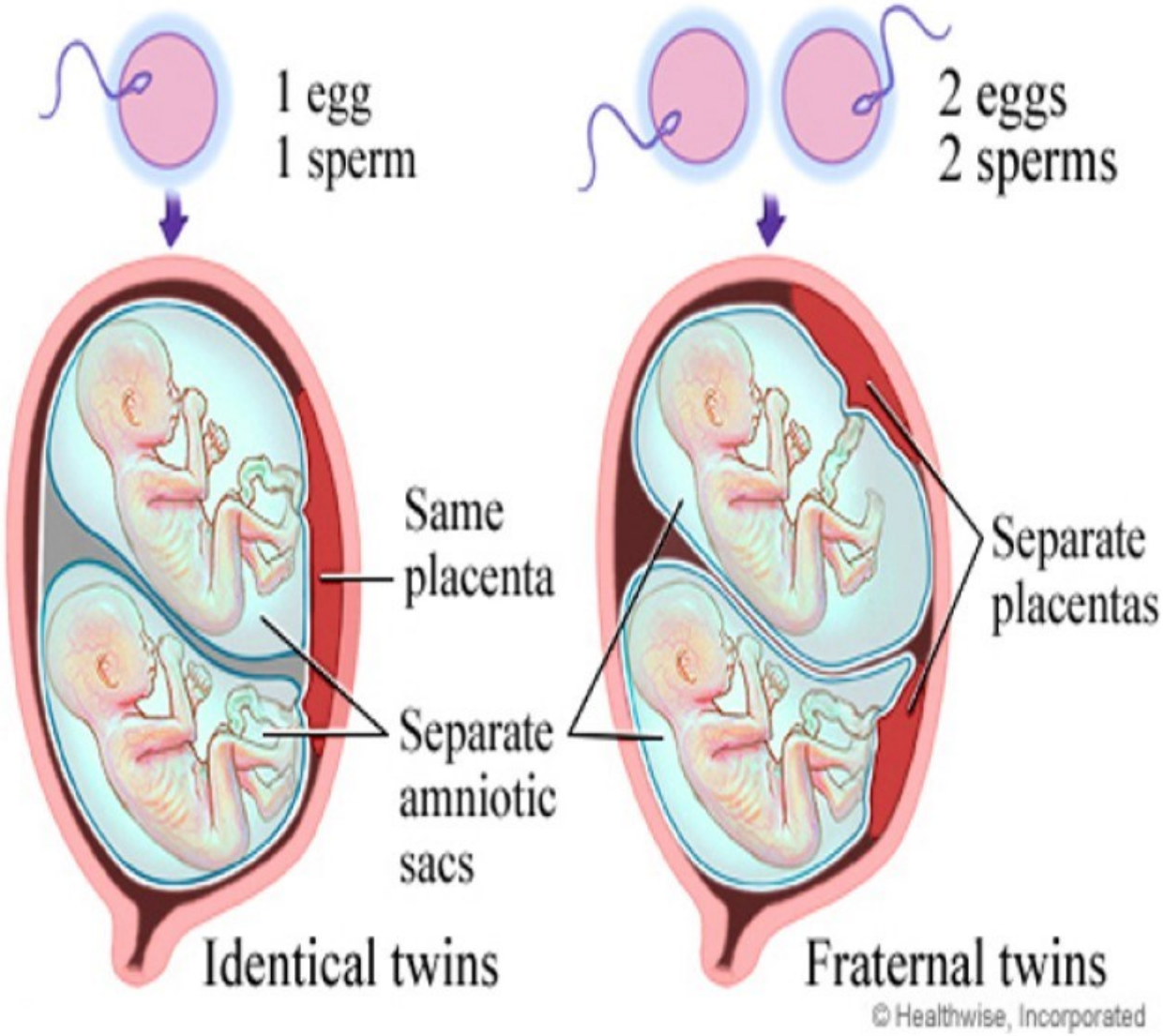
Monozygotic
(Monochorionic, Monoamniotic)

- If division occurs very late, cleavage may not be complete and conjoined, or **“ Siamese” twins** could result.
- Monozygotic twinning rate is between 3.5 and per 1000 births.
- No association with race, heredity, maternal age, or parity has been found.
- Use of fertility drugs increases the incidence of monozygotic twinning.



The earlier splitting of the single zygote occurs, the more independently the twins will develop

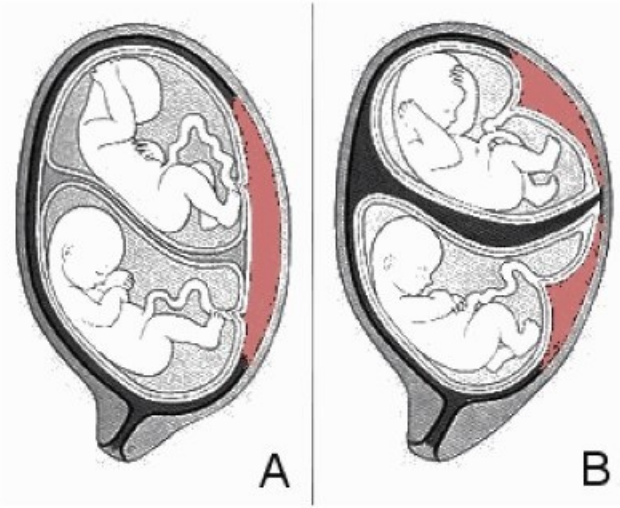
A.D.A.M.



Two Examples of Twinning

A. Identical Twins: Fetuses are of the same sex and share one placenta. One outer membrane envelops both amniotic sacs .

B . Fraternal Twins: Fetuses may be of different sex. There are two placentas and two separate amniotic sacs, each with its own membrane



Other multifetal pregnancies

- The occurrence of multifetal pregnancies with three or more fetuses has increased with the use of fertility drugs and IVF.
- Triplets occur in approx. 1 of 1341 pregnancies. They can occur from the division of one zygote into two, with one of the two dividing again, producing identical triplets.
- Triplets can also be produced from two zygotes, one dividing into a set of identical twins and the second zygote a single fraternal sibling, or from three zygotes.
- Quadruplets, quintuplets, sextuplets have similar possible derivations.

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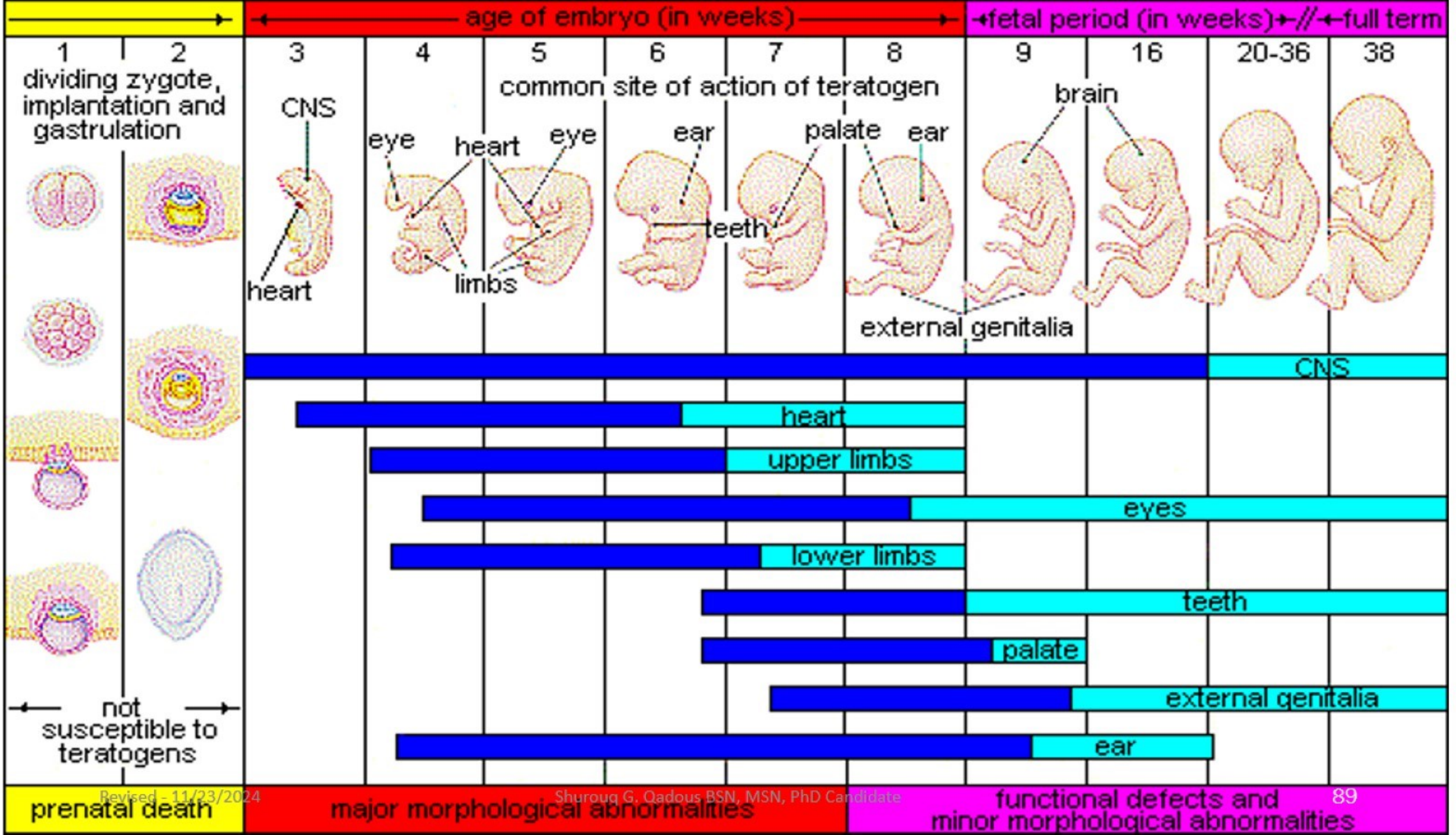
age of embryo (in weeks)
fetal period (in weeks)
full term
1
2
3
4
5
6
7
8
9
16
20-36
38
dividing zygote, implantation and gastrulation
common site of action of teratogen
CNS
heart
eye
heart
eye
limbs
ear
teeth
palate
ear
external genitalia
brain
not susceptible to teratogens
CNS
heart
upper limbs
eyes
lower limbs
teeth
palate
external genitalia
ear
prenatal death
major morphological abnormalities
functional defects and minor morphological abnormalities

Thanks