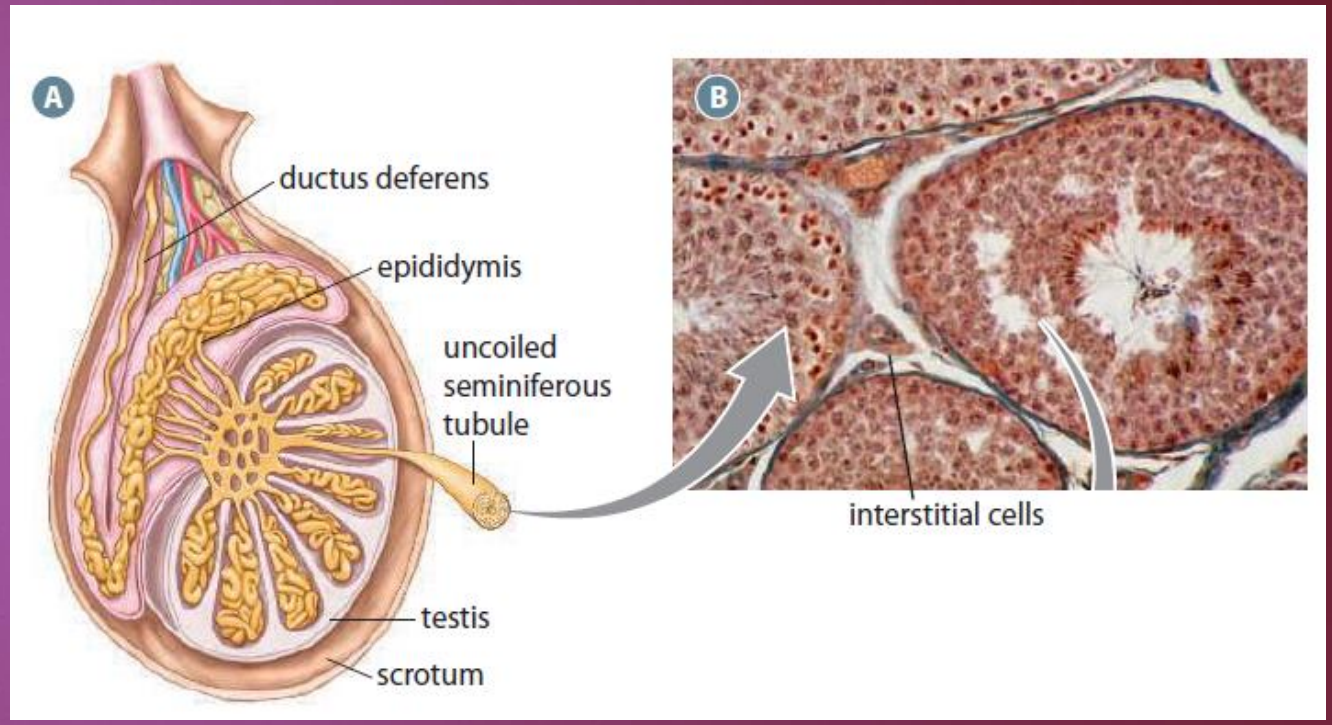
# Unit 1 Part 2
# Continuity of Human Life

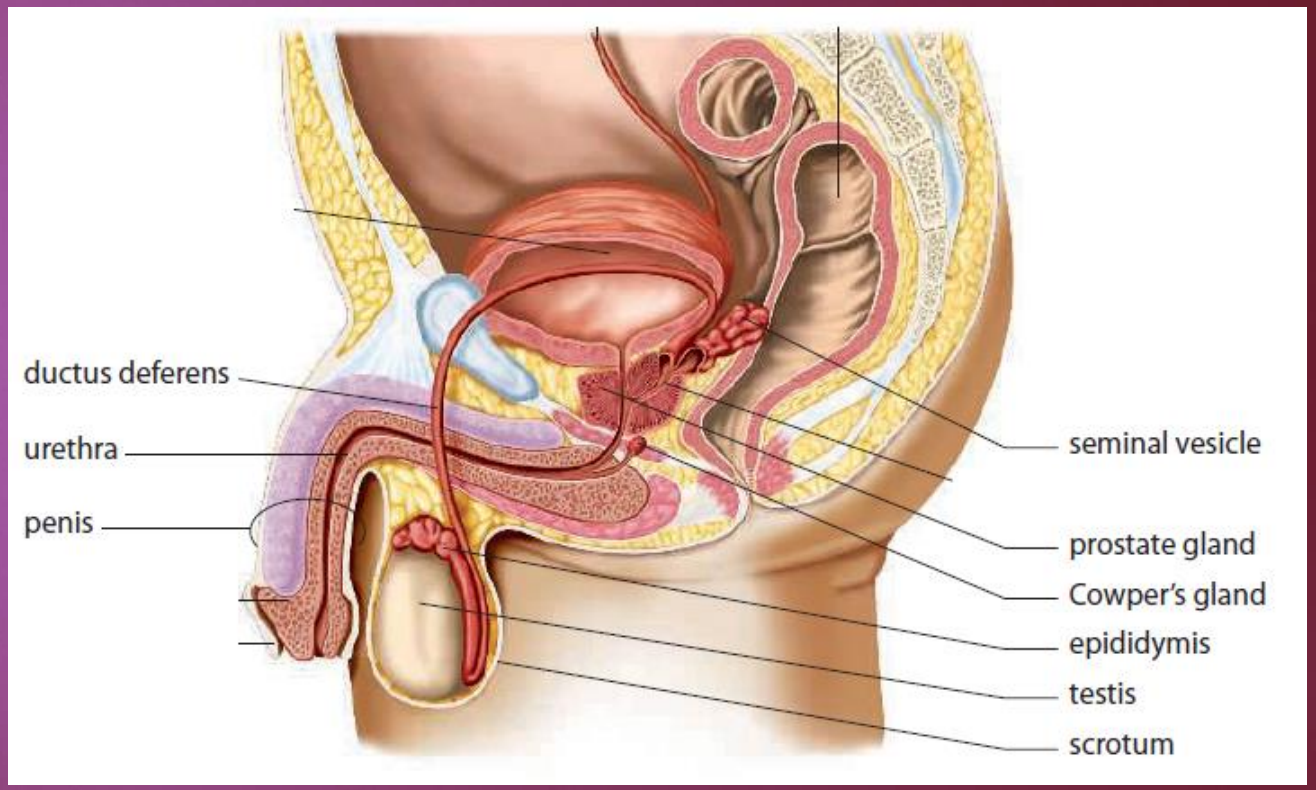
MR. GILLAM HOLY HEART

# Structures and Functions of the Male Reproductive System

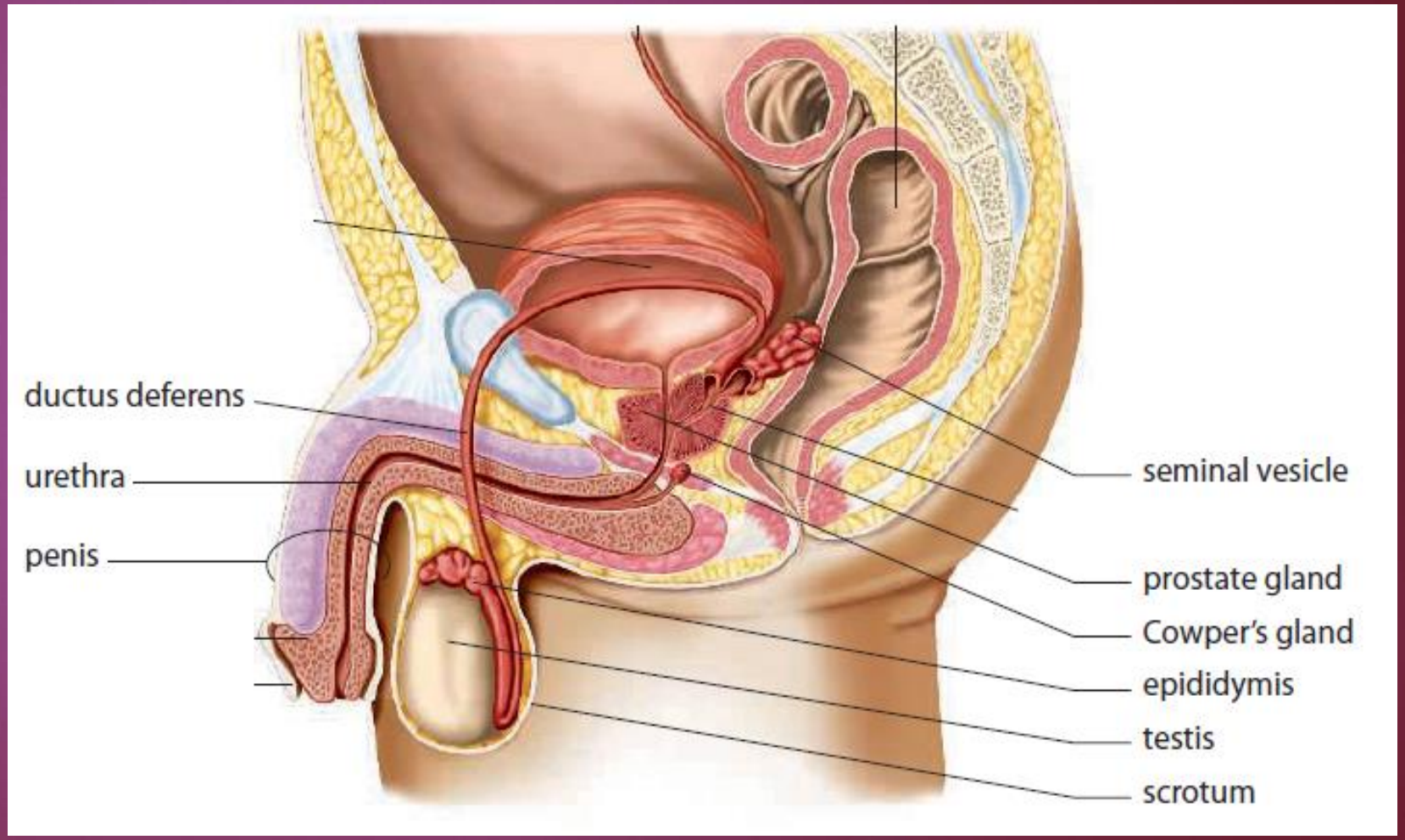
- **Testes (gonads)** male reproductive organ that produces sperm – testis singular
- **scrotum** pouch that contains the testes
- **seminiferous tubule** tube in testes where sperm are produced
- **interstitial cells** cells in the testes that produce sperm.
- **epididymis** duct where sperm mature and become motile



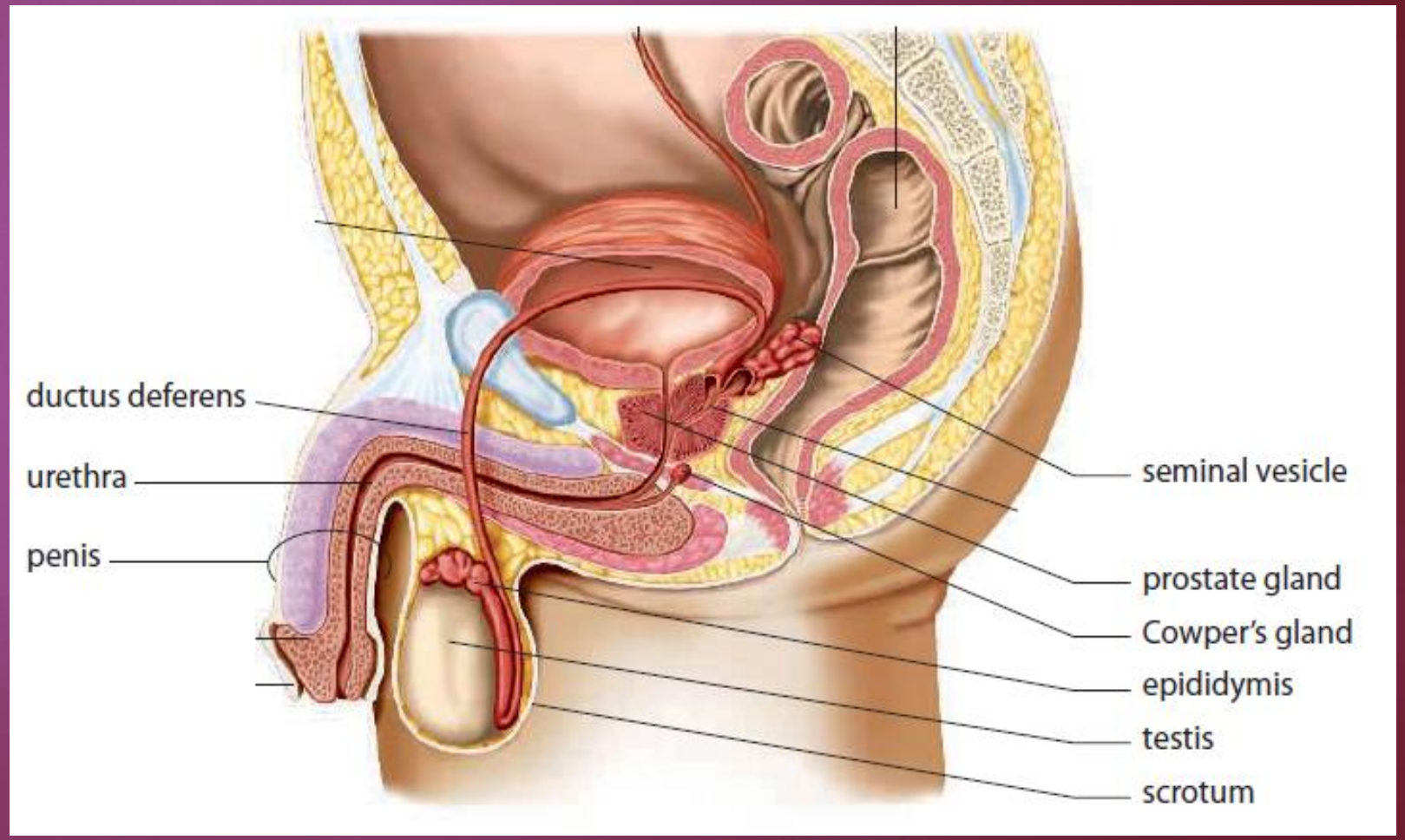
- **Vas (ductus) deferens** storage duct leading to the penis
- **penis** male organ for sexual Intercourse
- **Urethra (male)** the tube through which urine and semen exit the body



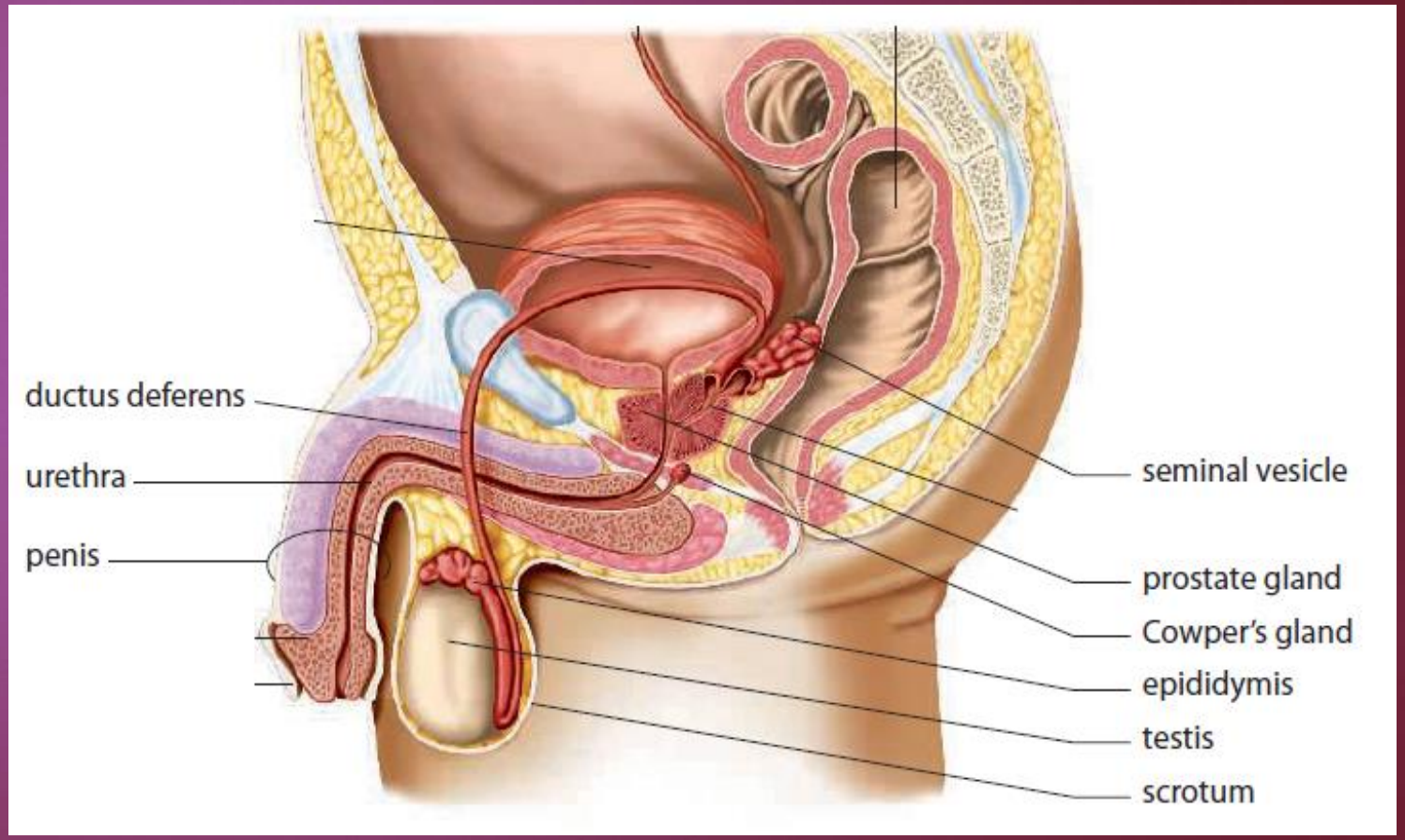
- **seminal vesicle** gland that secretes mucus containing the sugar fructose which is an energy source for sperm

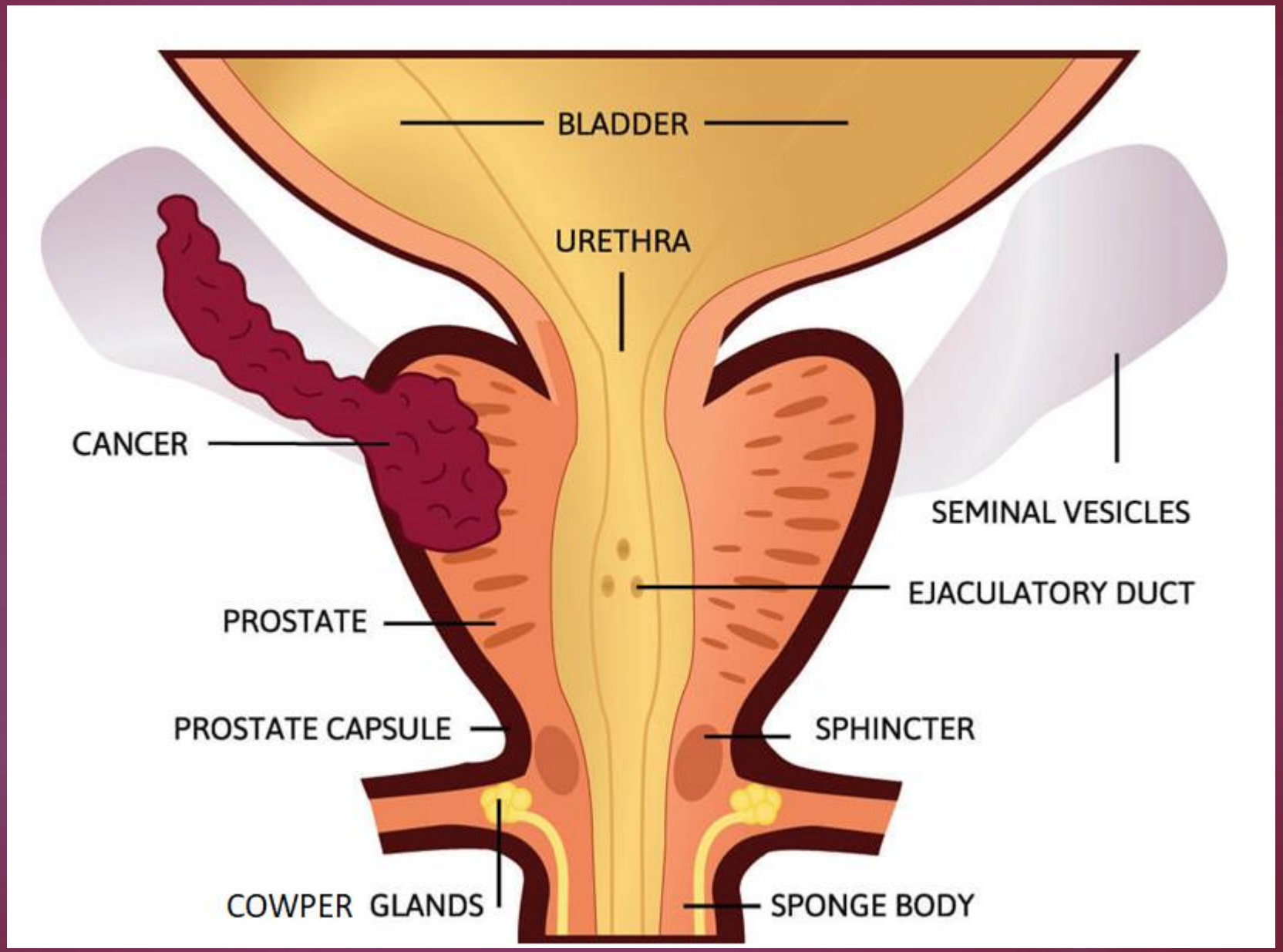


- **prostate gland** secretes alkaline fluid into the urethra
- milky fluid that increases the pH in the female reproductive tract, providing an environment best suited for sperm.
- Vagina is acidic



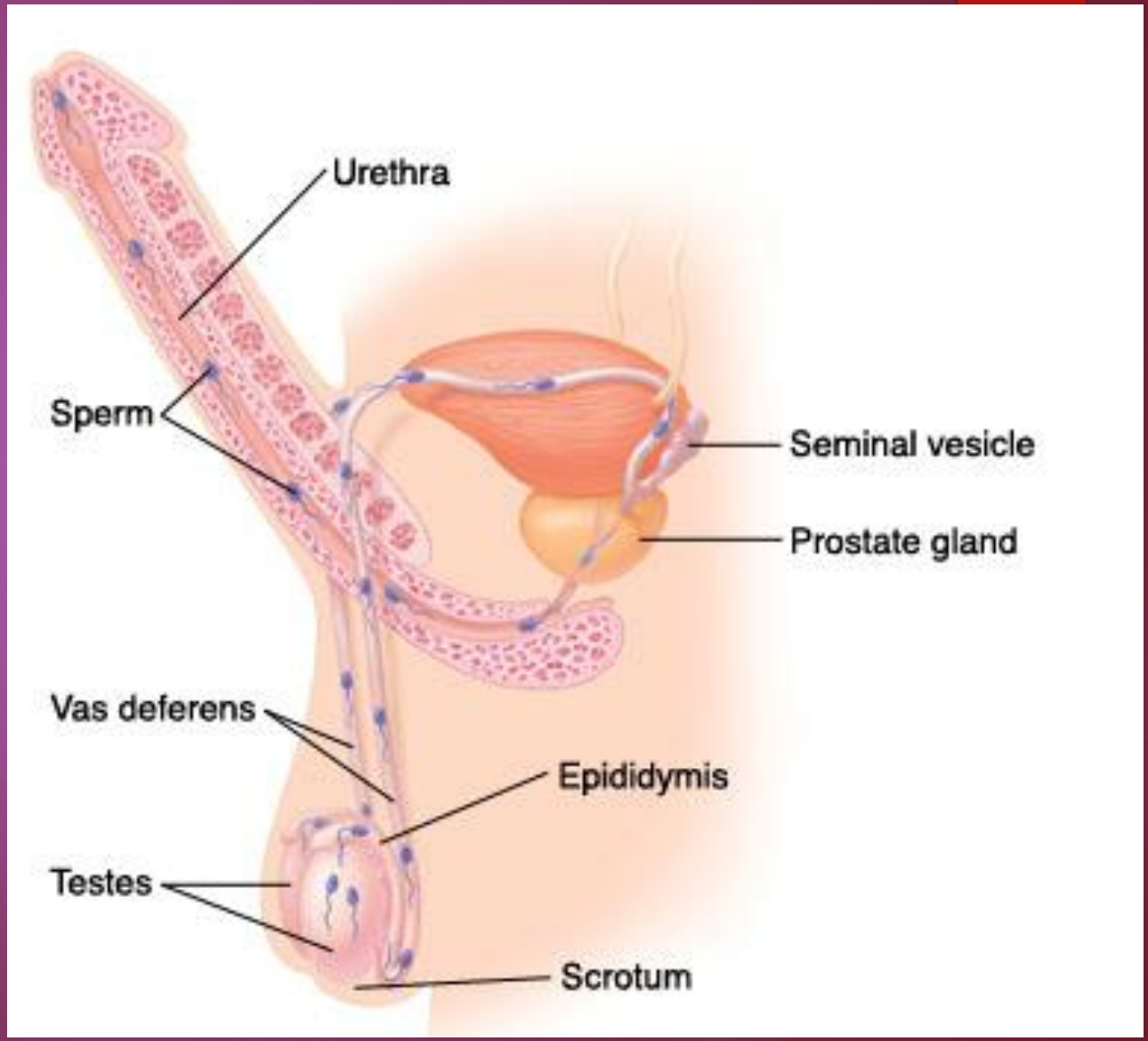
- **Cowper's gland** secretes mucus-like fluids into the urethra
- clear mucus fluid that aids in lubrication and neutralizes the acidity of any urine in the urethra.




BLADDER
URETHRA
CANCER
SEMINAL VESICLES
EJACULATORY DUCT
PROSTATE
PROSTATE CAPSULE
SPHINCTER
COWPER GLANDS
SPONGE BODY

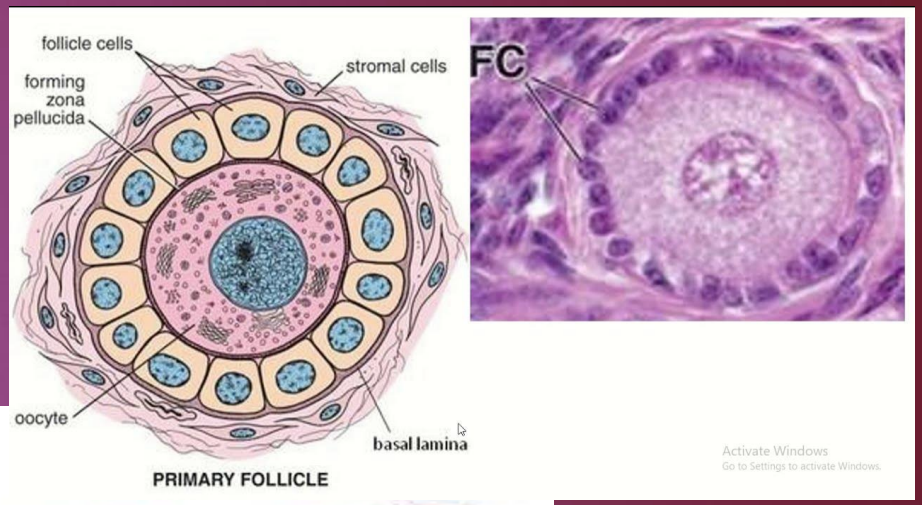
# Sperm Pathway

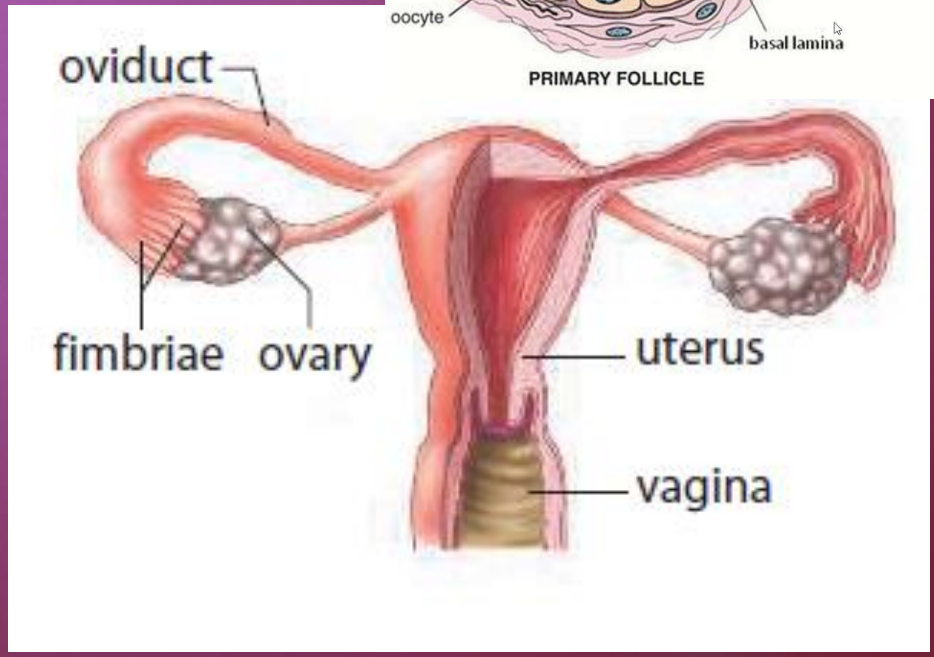
- Seminiferous Tubules
- Epididymis
- Vas Deferens
- Seminal Vesicles add fluid
- Prostate Gland adds fluid
- Cowper's Gland adds fluids
- Urethra



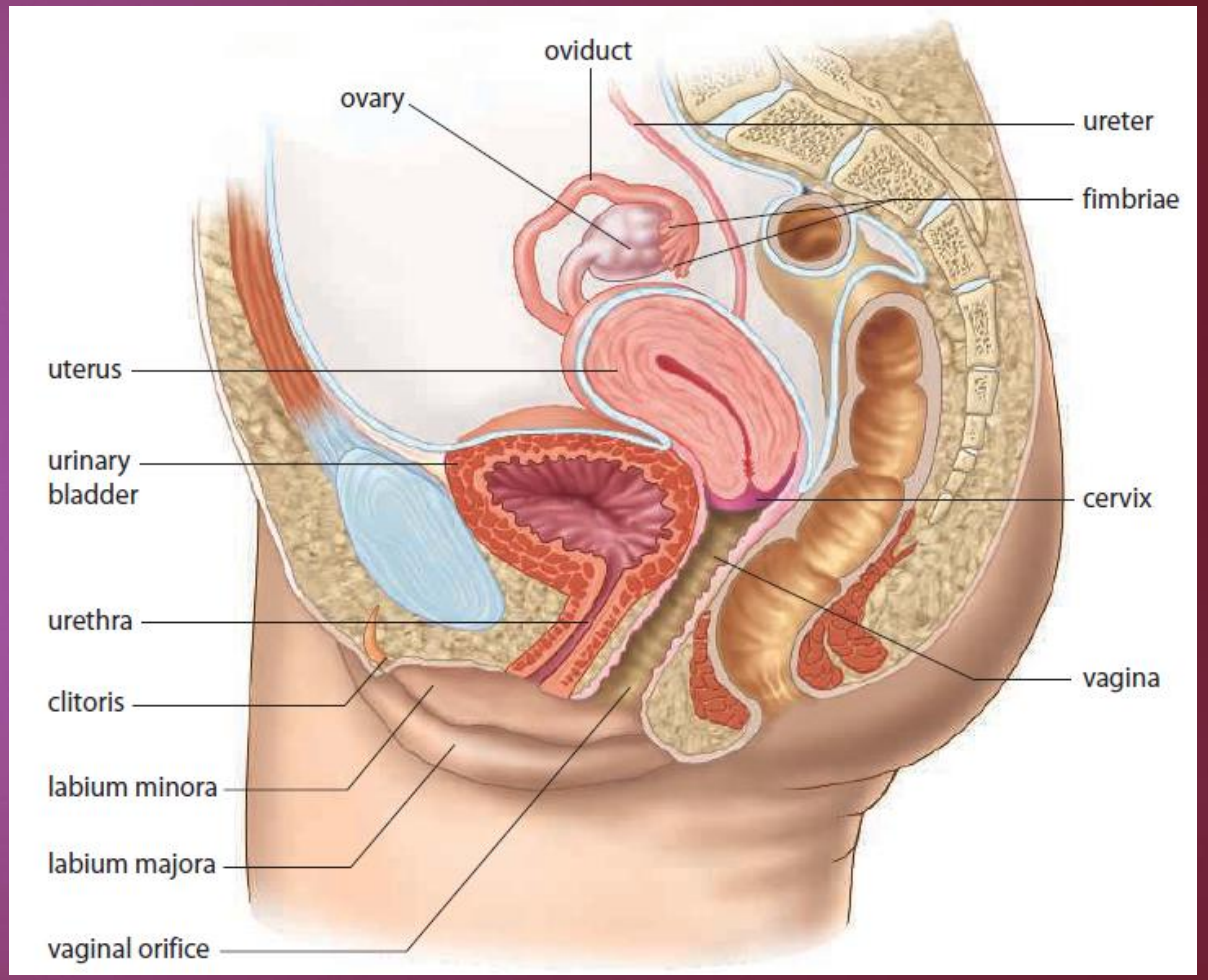
# Structures and Functions of the Female Reproductive System

- **Ovaries (gonads)** one of a pair of female reproductive organs
- **follicle** structure in the ovary that contains an ovum
- **fimbriae** projections that sweep ova from the ovary to the oviduct
- **Oviduct (fallopian tube)** cilia-lined tube that transports ova from the ovary to the uterus



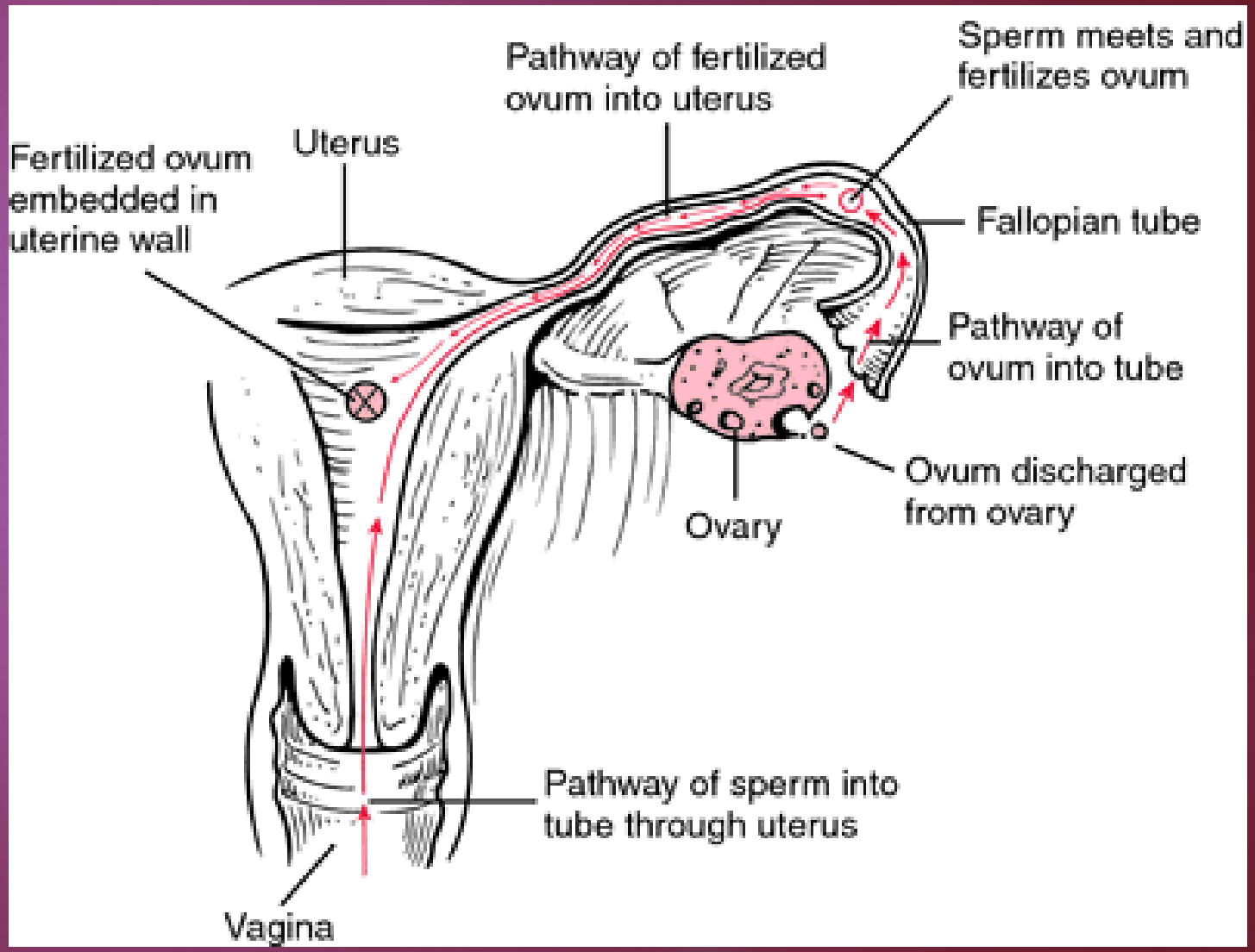



- **uterus** organ in which an embryo develops before birth
- **endometrium** membrane that lines the uterus; provides nutrients to the fetus
- **cervix** opening of the uterus toward the vagina
- **vagina** tube that leads from the exterior to the uterus



# Egg Pathway

- Ovary
- Oviduct (fallopian tube)
- Uterus
- Fertilization occurs in the fallopian tube.



Facilitate Investigation 13.A (*NL Biology*, p. 491)

Examining Gonads and Gametes

# Research Project

- In groups of **2** or by yourself research a common sexually transmitted infection (STI) (e.g., chlamydia, gonorrhea, hepatitis, herpes, human immunodeficiency virus [HIV], human papillomavirus [HPV], syphilis)
- using information sources they've evaluated and deemed credible and reliable.
- Their research should identify
  - whether the selected STI is viral or bacterial
  - risks for transmission
  - Symptoms
  - prevention information
  - testing, treatment
  - reproductive complications if left untreated.
  - Findings should be shared with peers. CREATE A POSTER!

# Sexually Transmitted Infections

- **Bacterial STIs**
  - Syphilis
  - Chlamydia
  - Gonorrhea
- **Viral STIs**
  - Hepatitis
  - Herpes
  - Human Immunodeficiency Virus [HIV]
  - Human Papillomavirus [HPV]

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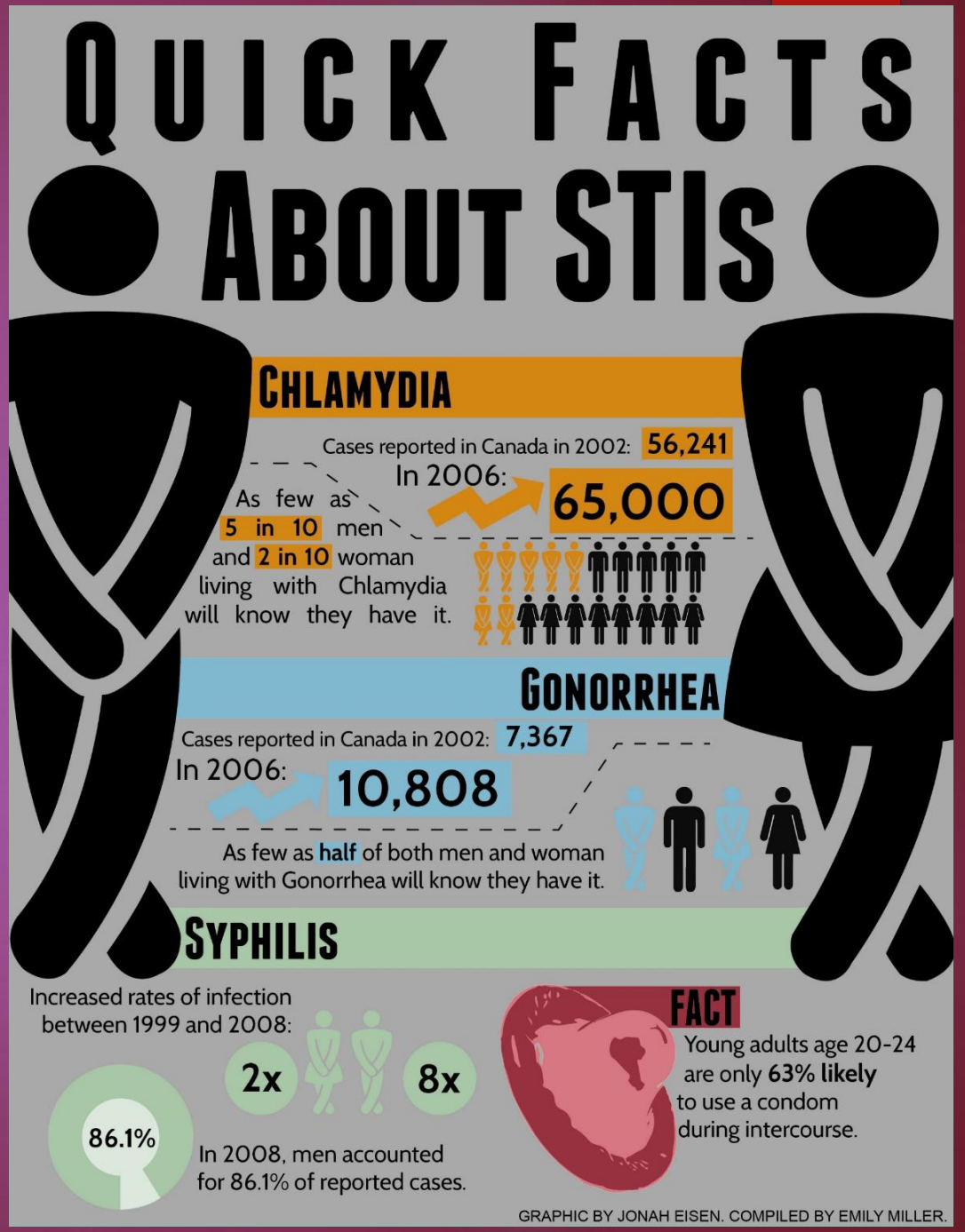


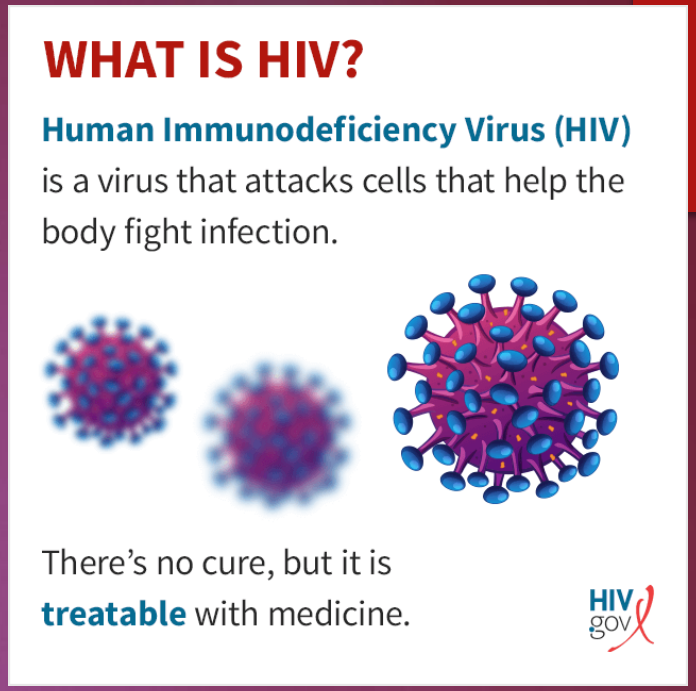
# Bacterial STI Treatment

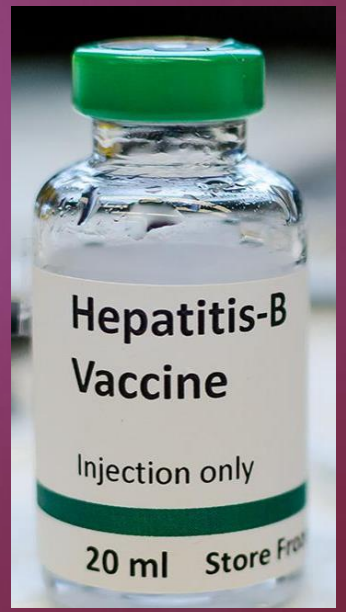
- Can be treated with antibiotics

# Viral STI Treatment

AIDS: There is no cure; treatments are available to manage the infection by lowering the level of virus, to reduce the spread of the virus in the body, and to treat diseases and infections that are associated with having AIDS.

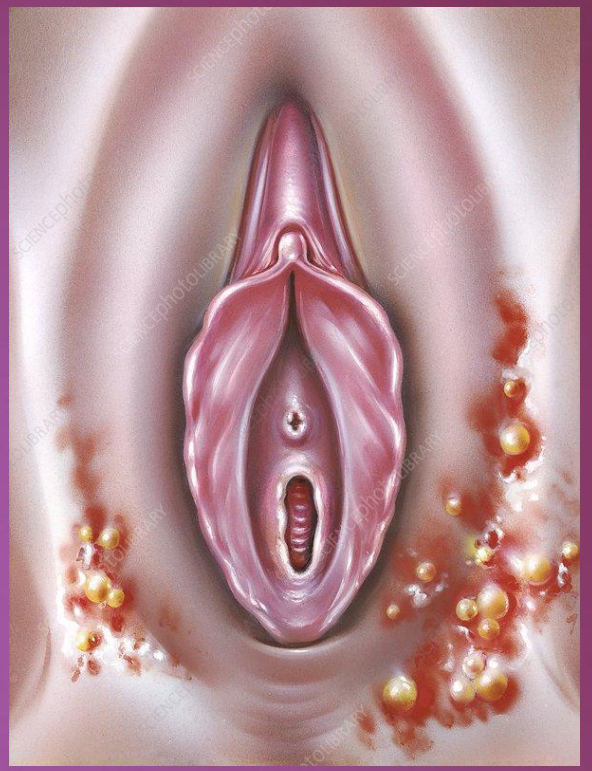
Hepatitis: A vaccine for hepatitis B is available. Most adults who are infected will clear the virus naturally, without treatment. Those who do not clear the virus can develop acute hepatitis B, for which there is no specific treatment.

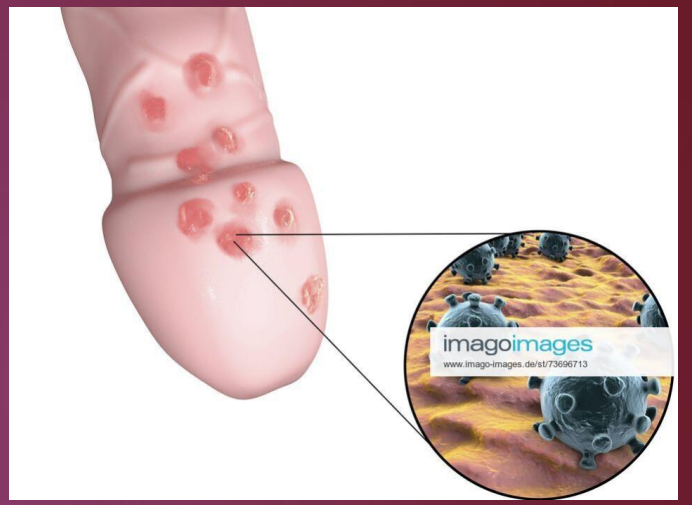


# Viral STI Treatment

Genital Herpes: There is no cure or vaccine; once someone is infected the individual carries the virus for life. Antiviral medications can help control and diminish the severity of outbreaks.

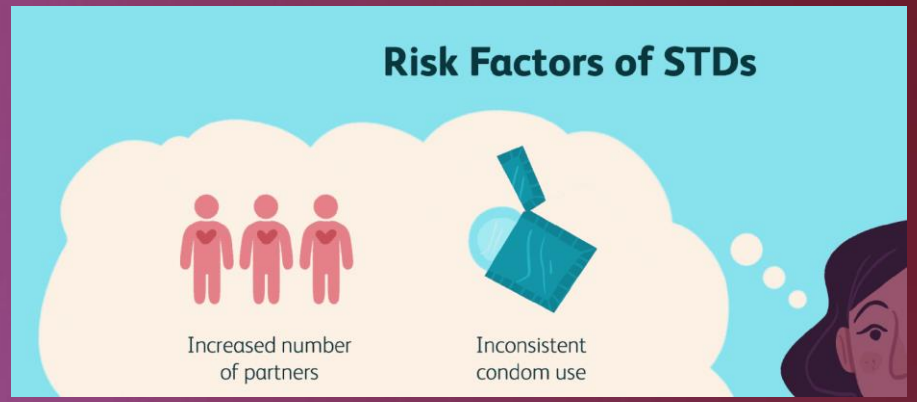





HPV: There is no treatment for the virus itself, but treatments exist for health problems the virus can cause. HPV vaccines are available; however, they do not protect against all cancer-causing types of HPV. Women (including those vaccinated) should undergo regular cervical cancer screening (Pap test).

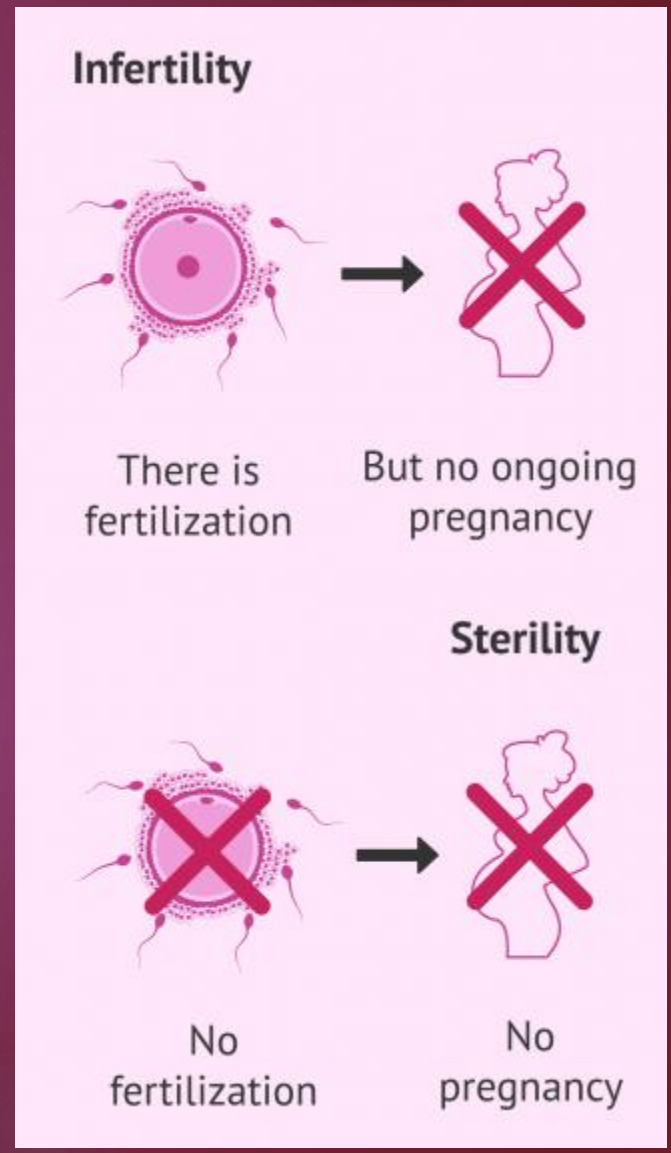
# STI Prevention

- Abstinence Not engaging in any sexual activity is the only sure protection against all STIs.
- long-term monogamous relationships with the same partner are generally safe, if neither partner has an STI. Some STIs, such as HPV, can be dormant for many years before symptoms appear, however. Many people who have STIs are not aware of their infection.
- Condoms using male or female condoms can reduce, but does not eliminate, the risk of STI transmission.
- Personal responsibility is crucial. For example, sexual practices that are known to increase the risk of STI transmission include having multiple partners or partners who use intravenous drugs. Any practices that involve contact between the genitals and the mouth or rectum also increase the risk of STI transmission.



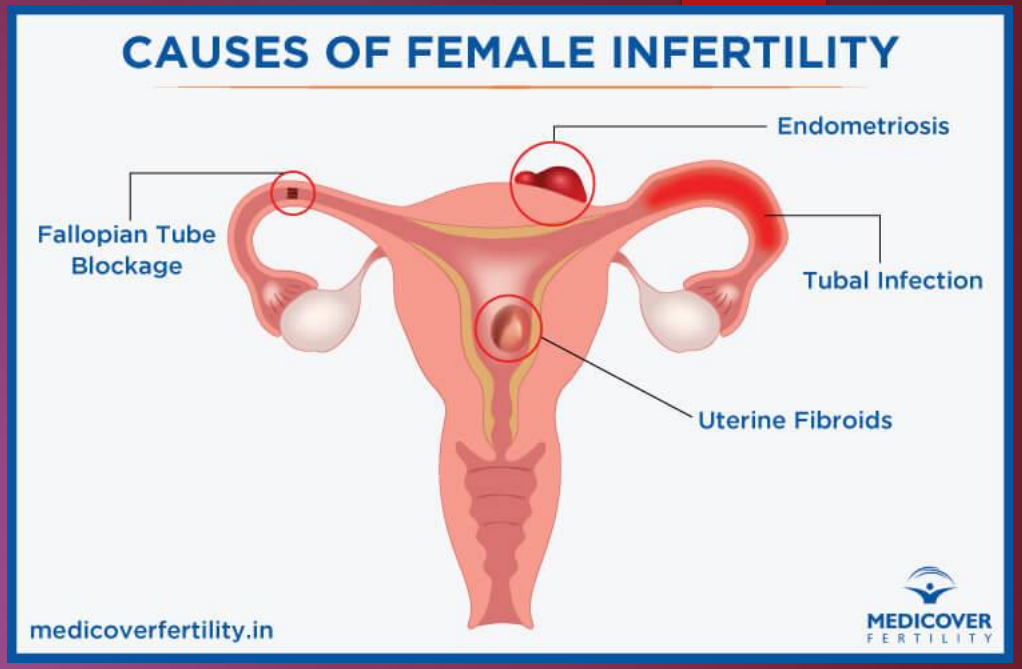
# Effects of STIs on Reproduction

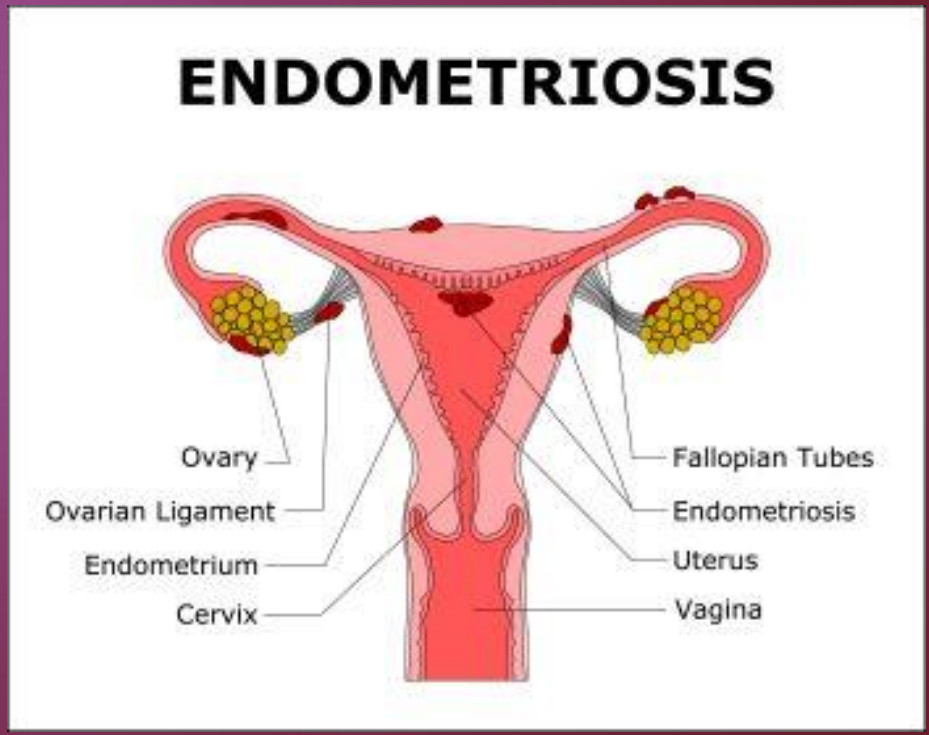
- Pelvic Inflammatory Disease (PID) - is an infection of a woman's reproductive organs.
- infertile condition when a man or woman has been unsuccessful for over a year at trying to conceive a child
  - Also failure or inability for a woman to carry a child to term.
- sterile a condition in which a man or woman is unable to have children
  - failure to conceive a child, male or female gametes are not viable. Most often used to describes males.
- *Sterility and Infertility are often used interchangeably as both mean the inability to sexually reproduce.



# Female Infertility

- A woman may be infertile or sterile for any of these reasons:
- 1.) blocked oviducts, often an effect of STIs
- 2.) failure to ovulate, caused by hormonal imbalances that occur for a variety of reasons, including being malnourished
- 3.) endometriosis, a painful condition in which endometrial tissues grow outside the uterus
- 4.) damaged eggs, which may be caused by environmental factors such as exposure to toxic chemicals or radiation



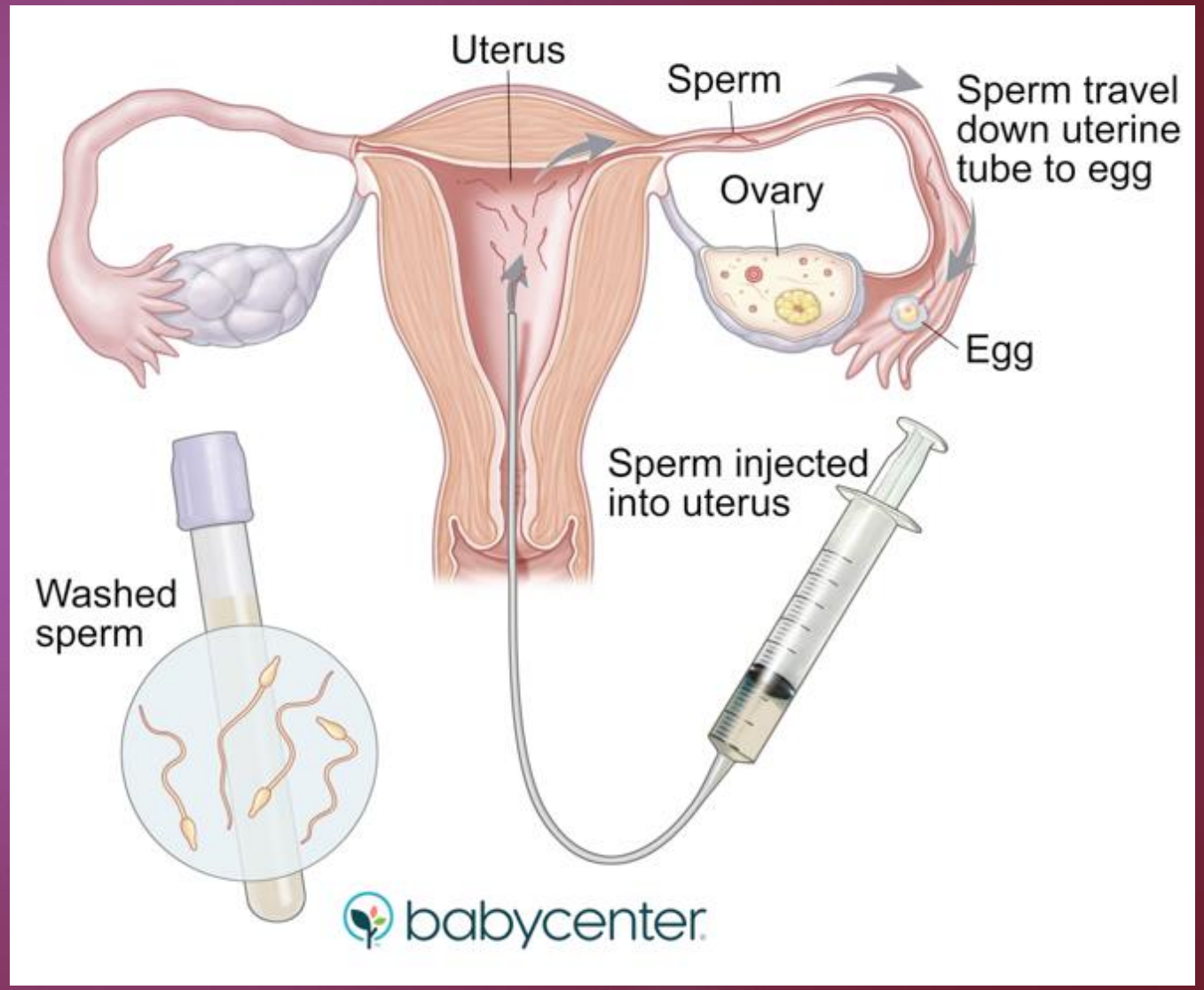



# Male Infertility

- A man may be infertile or sterile for any of the following reasons:
- 1.) **obstruction** in the ductus deferens or epididymis, which may be caused by complications arising from STIs or from other blockages in the testicles
- 2.) **low sperm count**, caused by numerous factors including overheated testicles, smoking, and alcohol intake
- 3.) high proportion of abnormal or **non-viable sperm**, caused by factors including overheated testicles, exposure to toxic chemicals or radiation, and infections such as STIs
- 4.) **inability to achieve an erection or ejaculation** (also known as erectile dysfunction or impotence), caused by factors including vascular disease, nervous system injury, stress, hormonal imbalance, medication, smoking, and alcohol intake

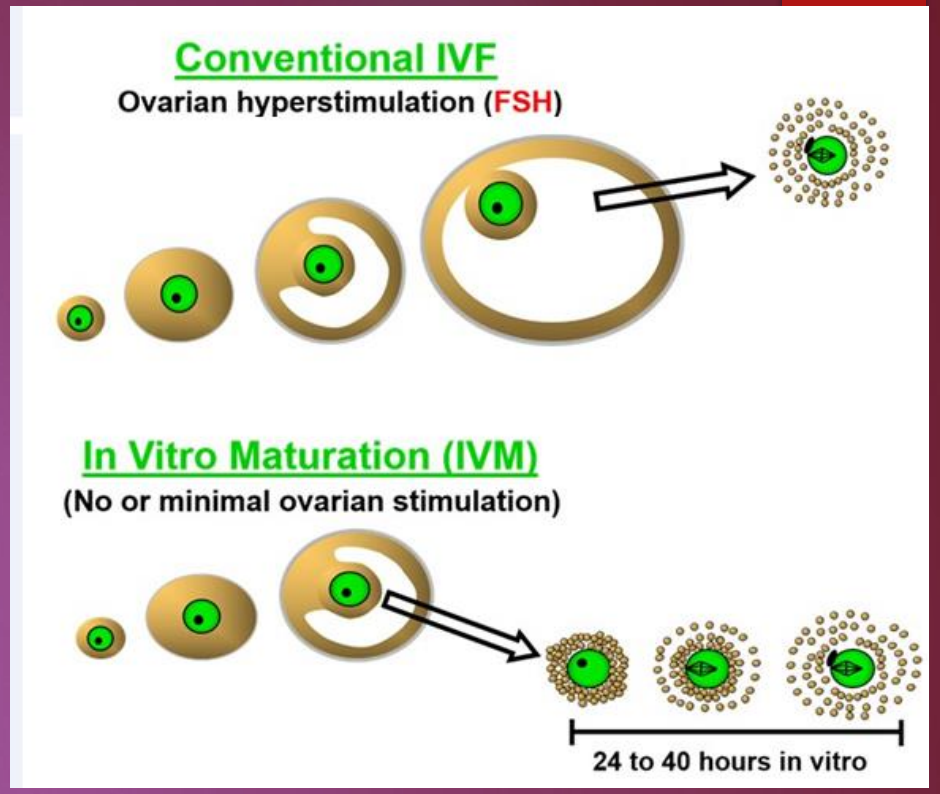
# How to Enhance Conception

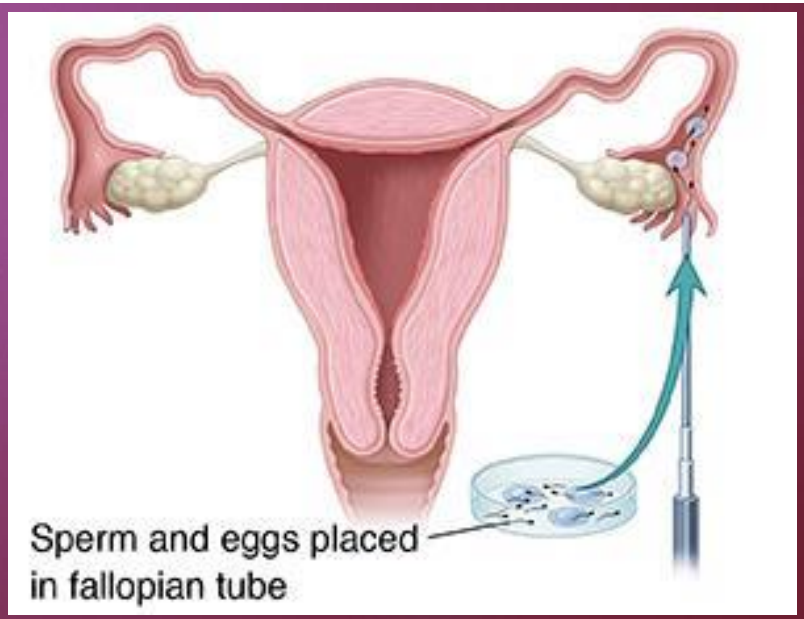
- **Artificial insemination** continues to be refined and is still useful when the man is sterile or infertile. Sperm are collected and concentrated before being placed in the woman's vagina. In some cases, the sperm are donated by the woman's male partner. In other cases, sperm banks are a source of sperm.



- ***in vitro fertilization* (IVF),** offers a solution for women with blocked oviducts.
- Ultrasound machines are used to identify specific follicles that are close to ovulation,
- Stimulation of the ovaries brings a woman's eggs to maturity and these eggs can be retrieved directly from these follicles.
- The eggs are combined with sperm in laboratory glassware.
- After fertilization, the developing embryo is placed in the uterus.

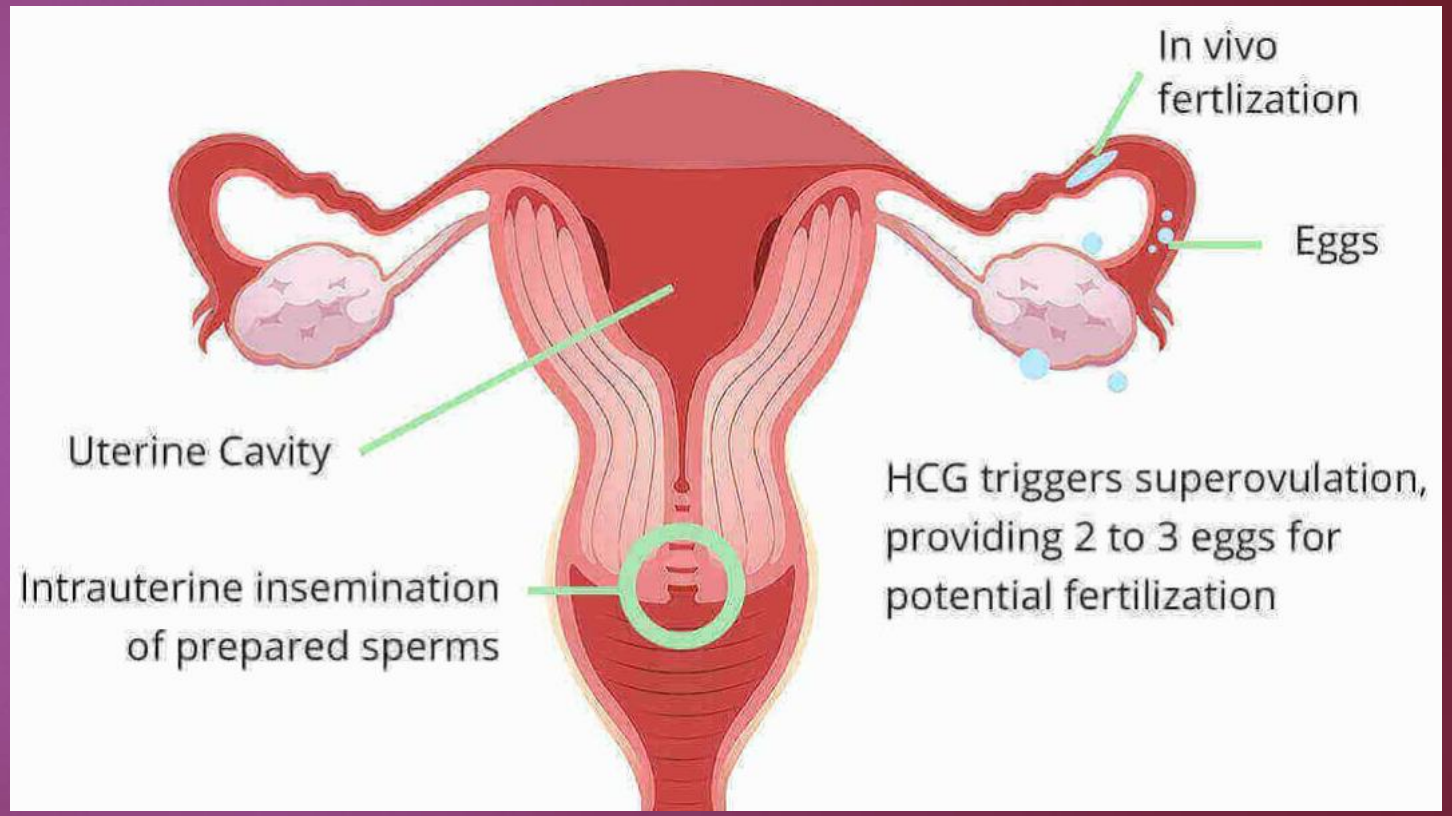
- Different variations of IVF have been developed.
- in vitro maturation (IVM) involves retrieving immature eggs that are treated in the lab, avoiding risks associated with stimulating ovaries.
- gamete intrafallopian transfer (GIFT), the eggs and sperm are brought together in the oviduct rather than in vitro. This procedure has a higher success rate than IVF.



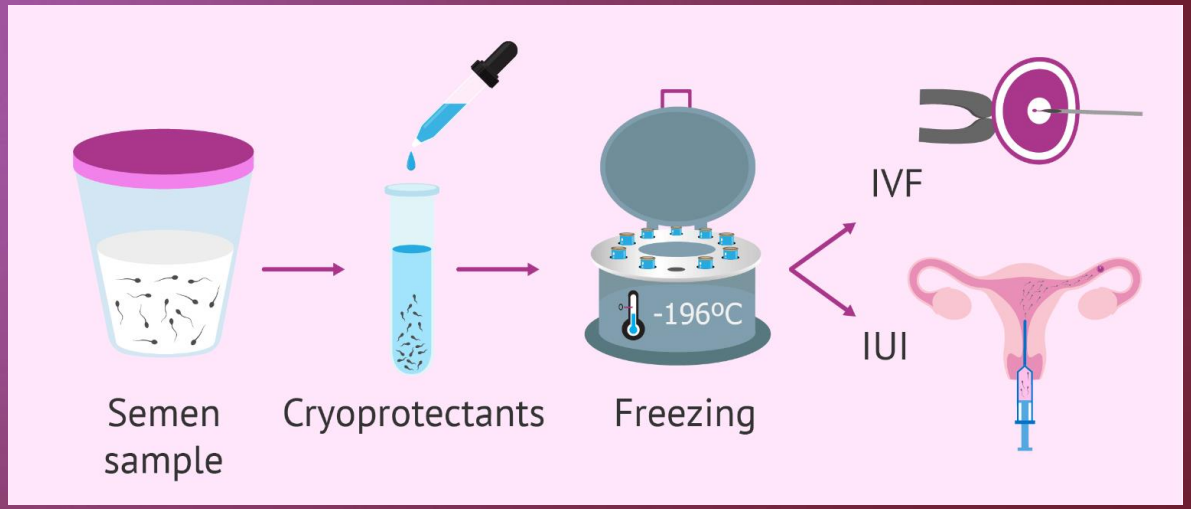



- **Surrogacy**
- Sometimes, an infertile couple contracts another woman to carry a baby for them.
- The woman who carries the baby is called the **surrogate mother**.
- Using AI or IVF, one or both gametes may be contributed by the contracting couple.

- **Superovulation** is the production of multiple eggs as a result of hormone treatment.
- Women who ovulate rarely or not at all may receive treatment with hormones that stimulate follicle development and ovulation.
- Superovulation is also often used in conjunction with other artificial reproductive technologies.



- **Cryopreservation** is the process of freezing eggs, sperm or embryos to sub-zero temperatures for later use.
- When the eggs, sperm or embryos are needed, they are thawed and fertilized or used in a fertility treatment cycle.
- Sperm may be used for intrauterine insemination (IUI) or in vitro fertilization (IVF) procedures.



# Activity

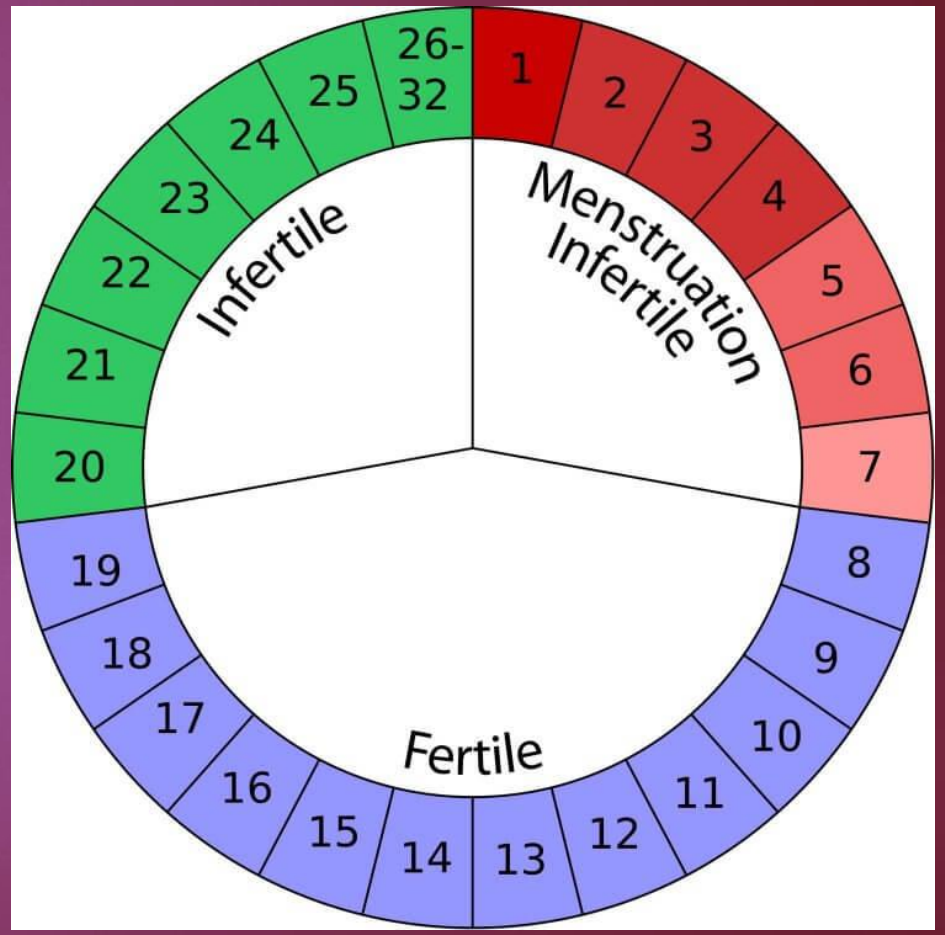
STSE CASE STUDY Reflecting on Reproductive Technologies

- Reproductive technologies provide a context to examine the relationships among science, technology, and society.
- Specifically, students should be able to answer the following questions.
- 1.) What are the risks and benefits to society of reproductive technology use
- 2.) What are the ethical and moral questions that arise from reproductive technology use
- 3.) What are the merits of funding research to enhance conception versus controlling human population growth.

# Preventing Conception

- Natural methods

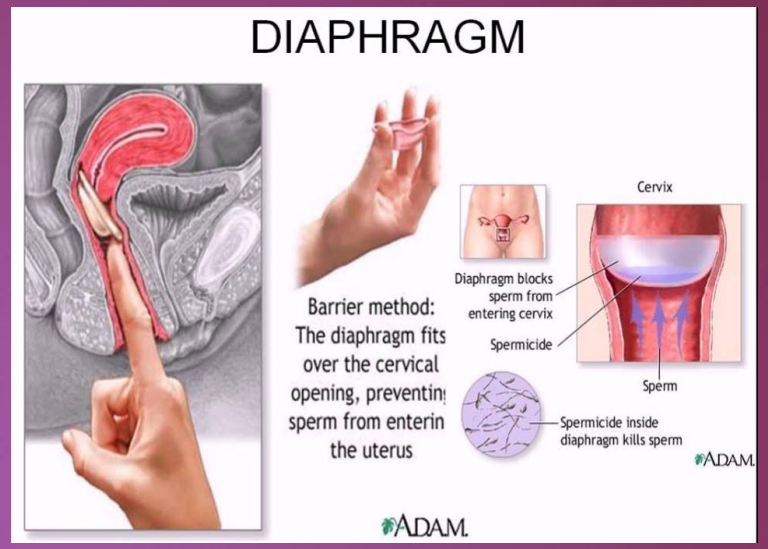
- Rely on behavioural practices of individuals
  - **abstinence** (complete lack of sexual intercourse)
  - **withdrawal** (the penis is withdrawn from the vagina and female external genitalia before ejaculation)
  - **fertility awareness:** refrain from sexual intercourse during time of woman's highest fertility (from 5 days before ovulation to 1 day after)



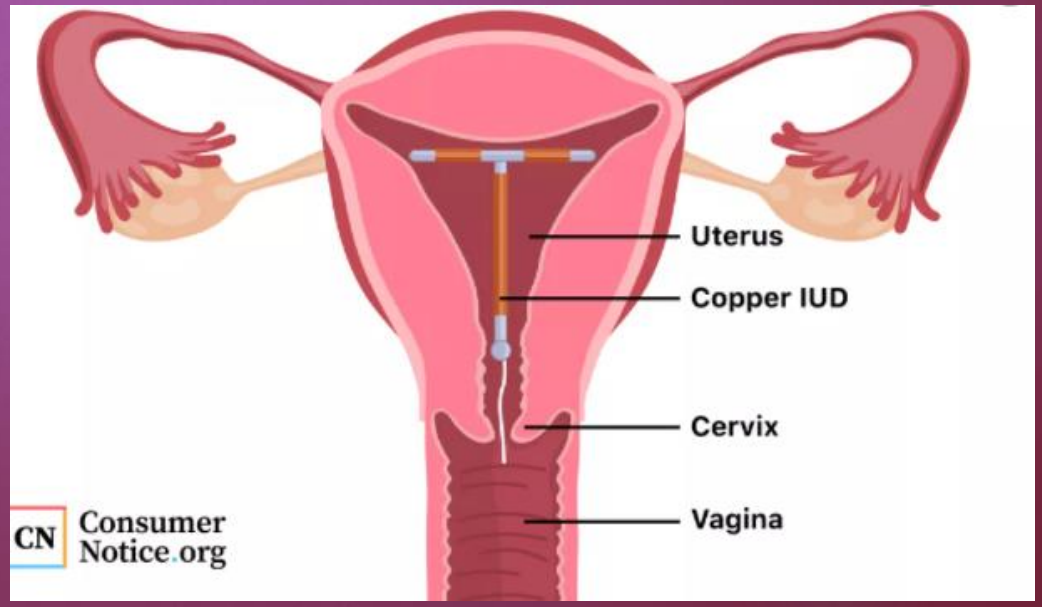
# Physical or Chemical Barriers

- Create a barrier between egg and sperm and/or alter the environment in the reproductive tract.
  - **condoms** (the male one covers the penis and the female one is inserted in the vagina)
  - the **sponge** (foam device that fits over the cervix and also contains a spermicide
  - **cervical cap (**silicone cap that fits against the cervix; should be used with a spermicide)

- **diaphragm** (latex barrier that covers the cervix; should be used with a spermicide)
- **copper IUD** (small T-shaped device inserted in the uterus)
- **spermicidal jellies, creams, or foams:** chemicals that destroy sperm on contact



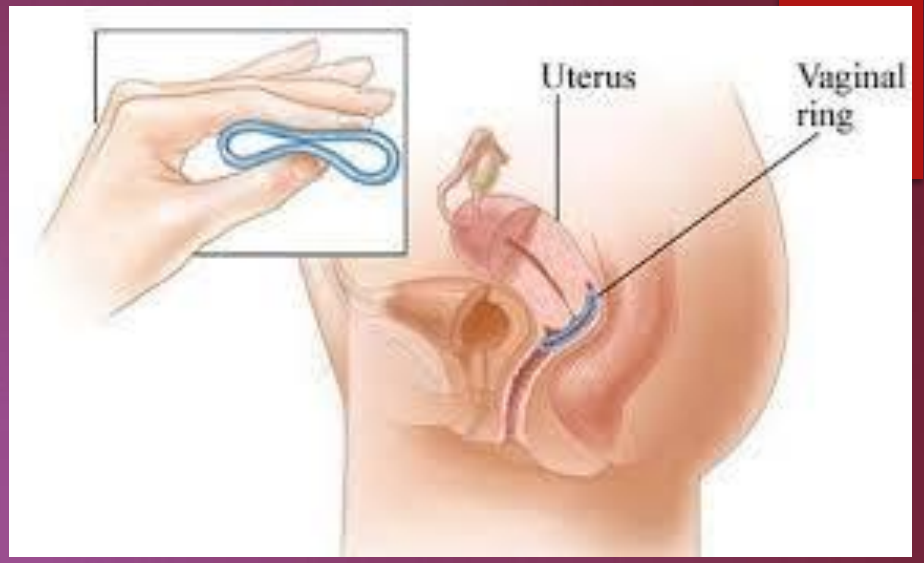


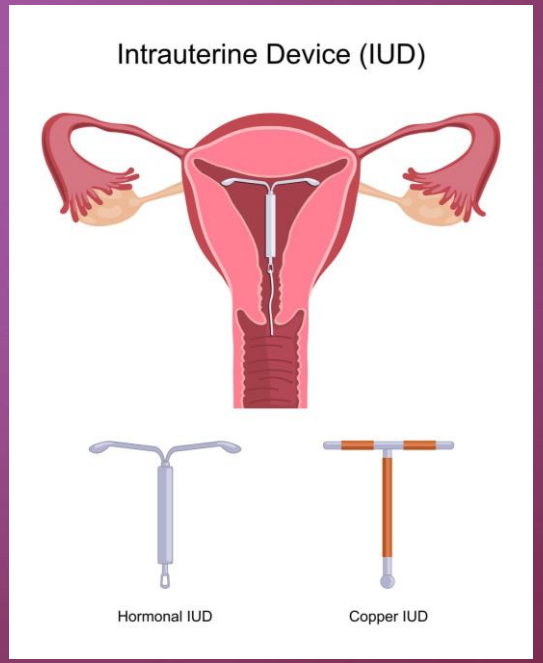


# Hormonal Contraception

- Several types are available that act by changing the balance of reproductive hormones in women, ensuring ovulation does not occur and cervical mucus and lining of the uterus is altered to inhibit implantation. These include
- birth control pill: contains either both estrogen and progestin or progestin only and taken daily
- patch: 4 × 4 cm patch worn on the skin that continually releases estrogen and progestin

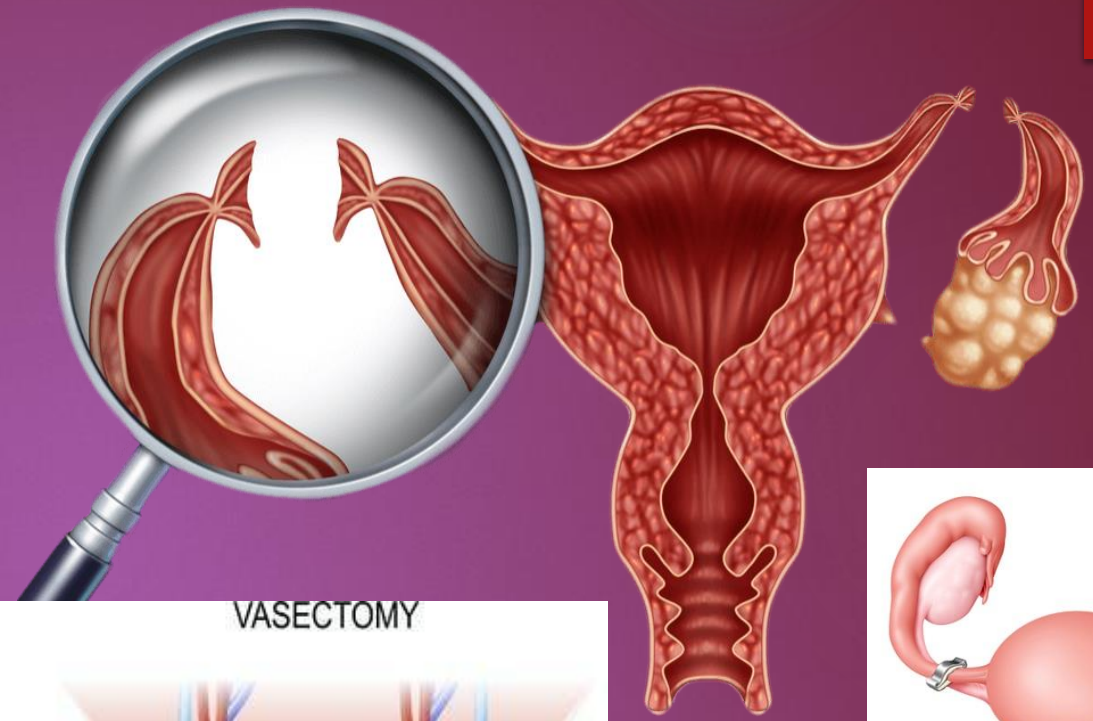

- vaginal ring: soft, flexible plastic ring that is inserted in the vagina, where it slowly releases estrogen and progestin
- intrauterine device (IUD): T-shaped device, inserted into the uterus by a doctor, that has a small cylinder with progestin that is slowly released
- injectable: progestin injection given four times a year
- emergency oral contraceptive (LNG-EC pills): not to be used as a regular method; contains a progestin with greatest efficacy if taken within 24 hours



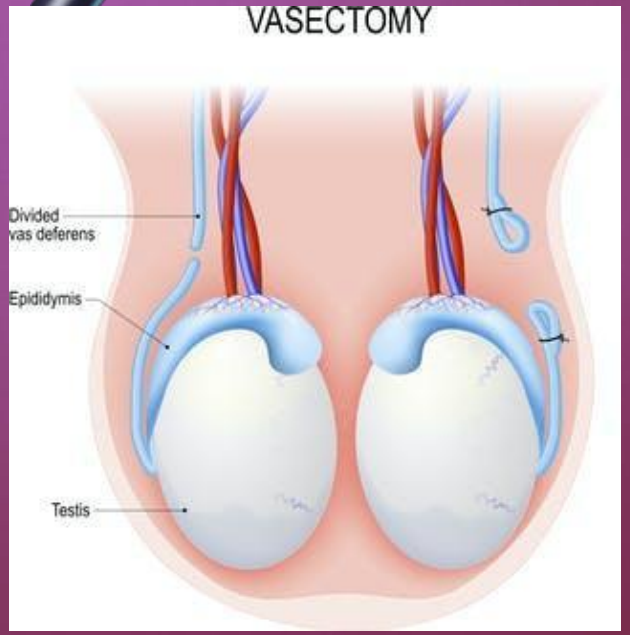



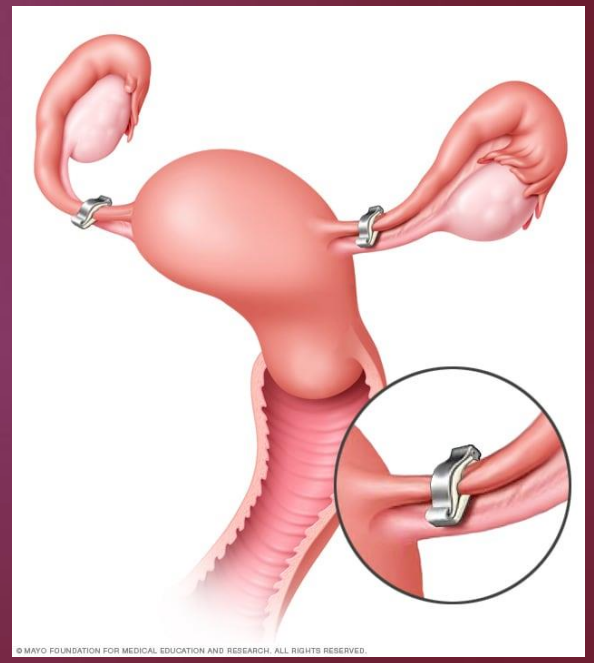

# Surgical Sterilization

- For women: tubal ligation, which involves cutting the oviducts and tying off the cut ends. This ensures that the ovum never encounters sperm and never reaches the uterus.



- For men: vasectomy, which involves cutting and tying off the ductus deferens. This ensures semen does not contain sperm.



# Contraception Research Project

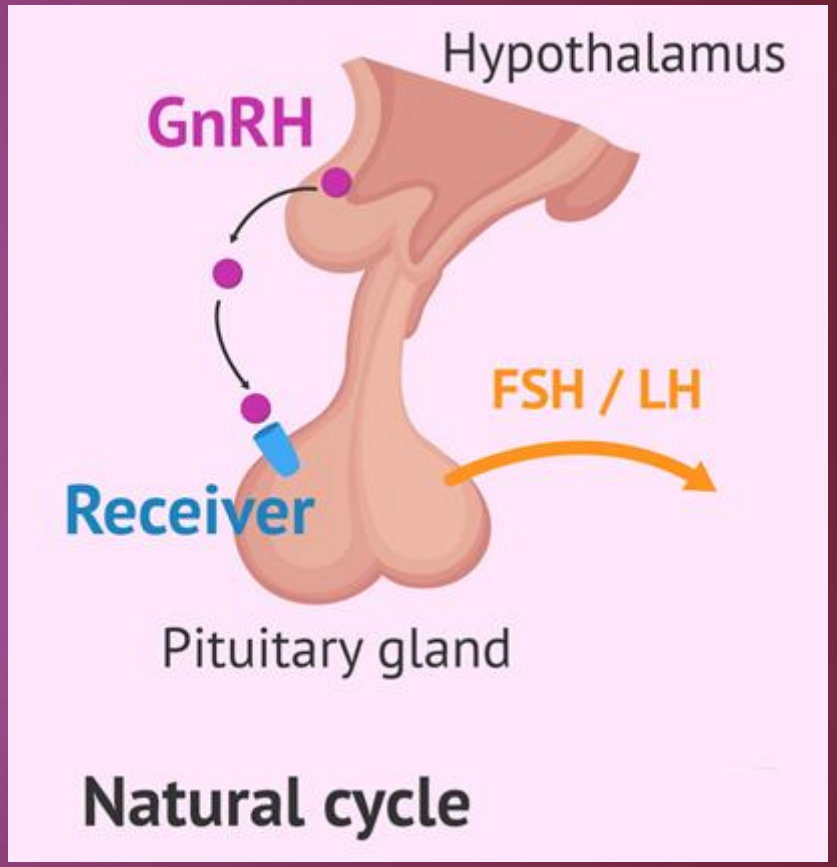
- Contraception Research Project
- In small collaborative groups, students are expected to research and evaluate conception prevention technologies using credible and reliable sources of information. They should consider factors such as the safety and effectiveness of specific reproductive technologies, identify advantages and disadvantages.

**Selected Technologies for Preventing Conception**

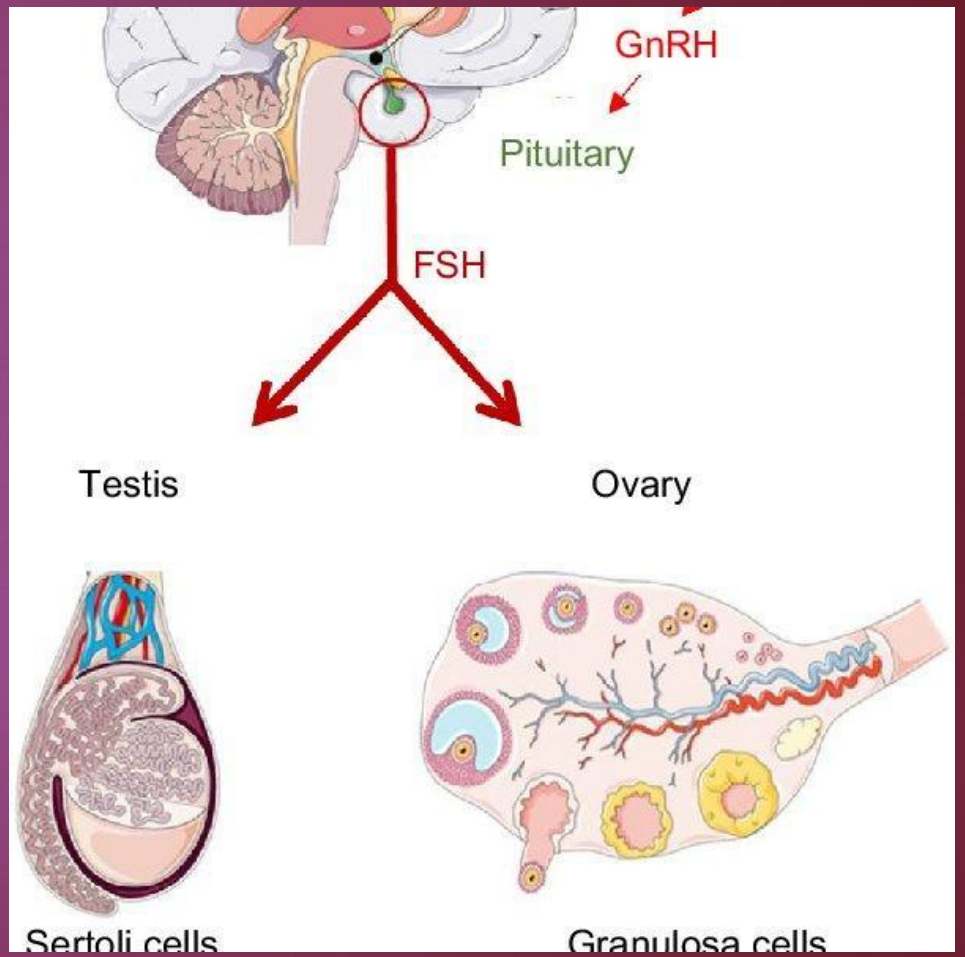
- condoms
- fertility awareness methods
- intrauterine device (IUD)
- lactational amenorrhea (LAM)
- oral contraceptives—pills that contain both estrogen and progestin (synthetic progesterone)
- progestin-only contraceptives
- spermicides
- tubal ligation
- vasectomy

# Reproductive Hormones

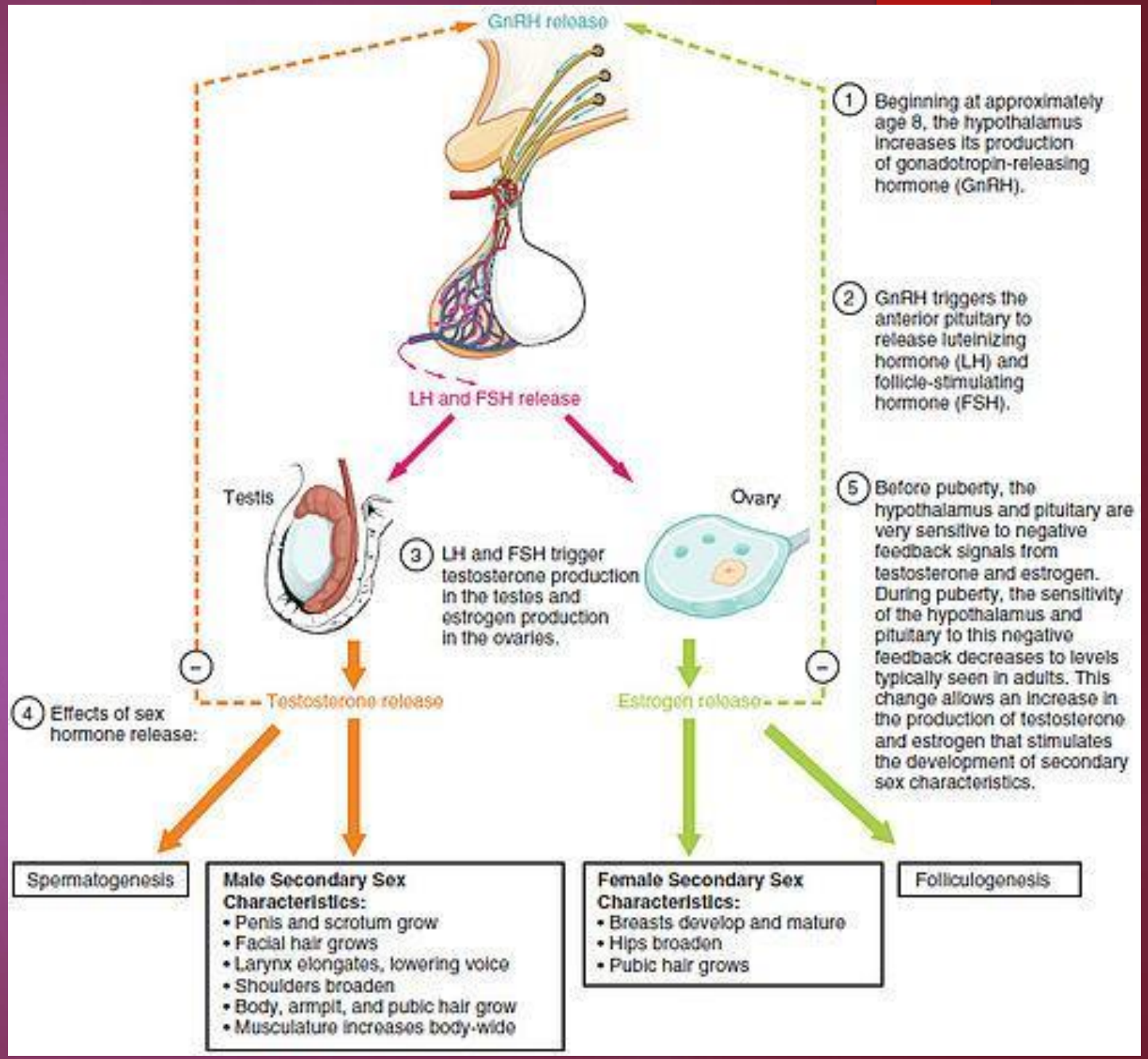
- **Gonadotropin Releasing Hormone (GnRH)**
  - Production Site: Hypothalamus
  - Target Organ or Gland: Anterior Pituitary
  - Function in Male Reproductive System: Stimulates the release of FSH and LH from the anterior pituitary
  - Function in Female Reproductive System: Stimulates the release of FSH and LH from the anterior pituitary



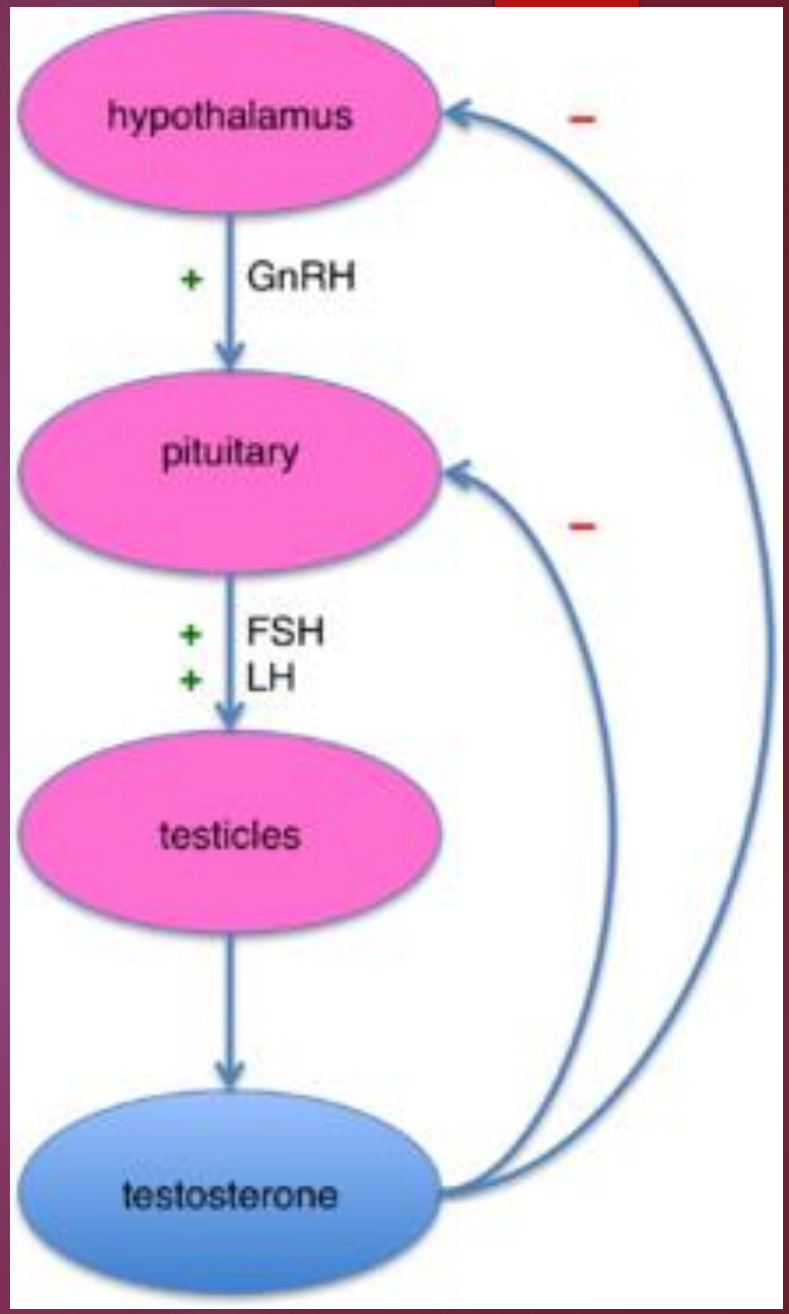
- **Follicle-Stimulating Hormone (FSH)**
  - Production Site: Anterior Pituitary
  - Target Organ or Gland: Testes and Ovaries
  - Male Reproductive System: Stimulates the development of the sex organs and gamete production
  - Function in Female Reproductive System: Stimulates the development of the sex organs and gamete production



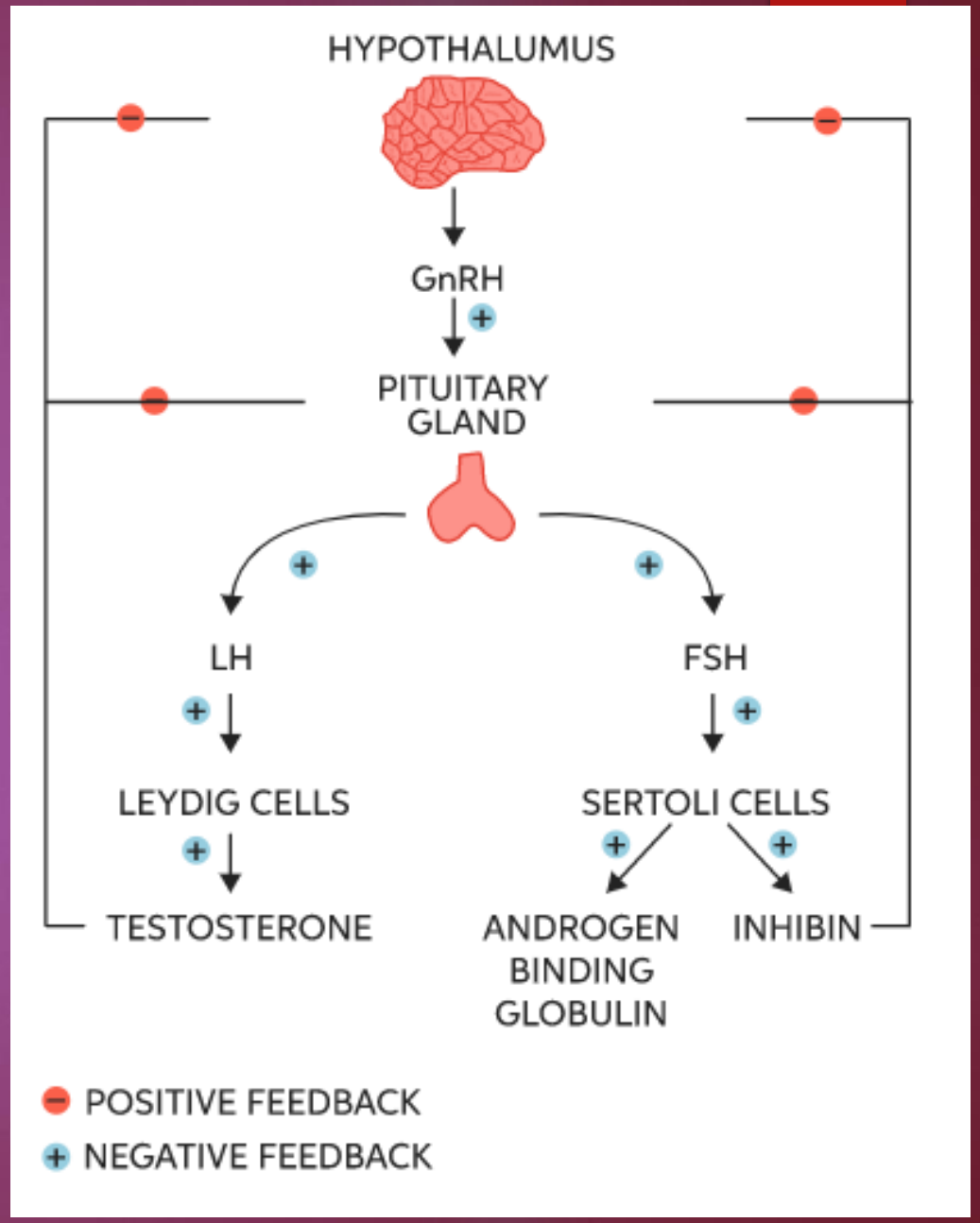
- **Luteinizing Hormone(LH)**
- Production Site: Anterior Pituitary
  - Target Organ or Gland: Testes and Ovaries
  - Male Reproductive System: Stimulates the production of testosterone
  - Function in Female Reproductive System: Triggers ovulation and (with FSH) stimulates estrogen production



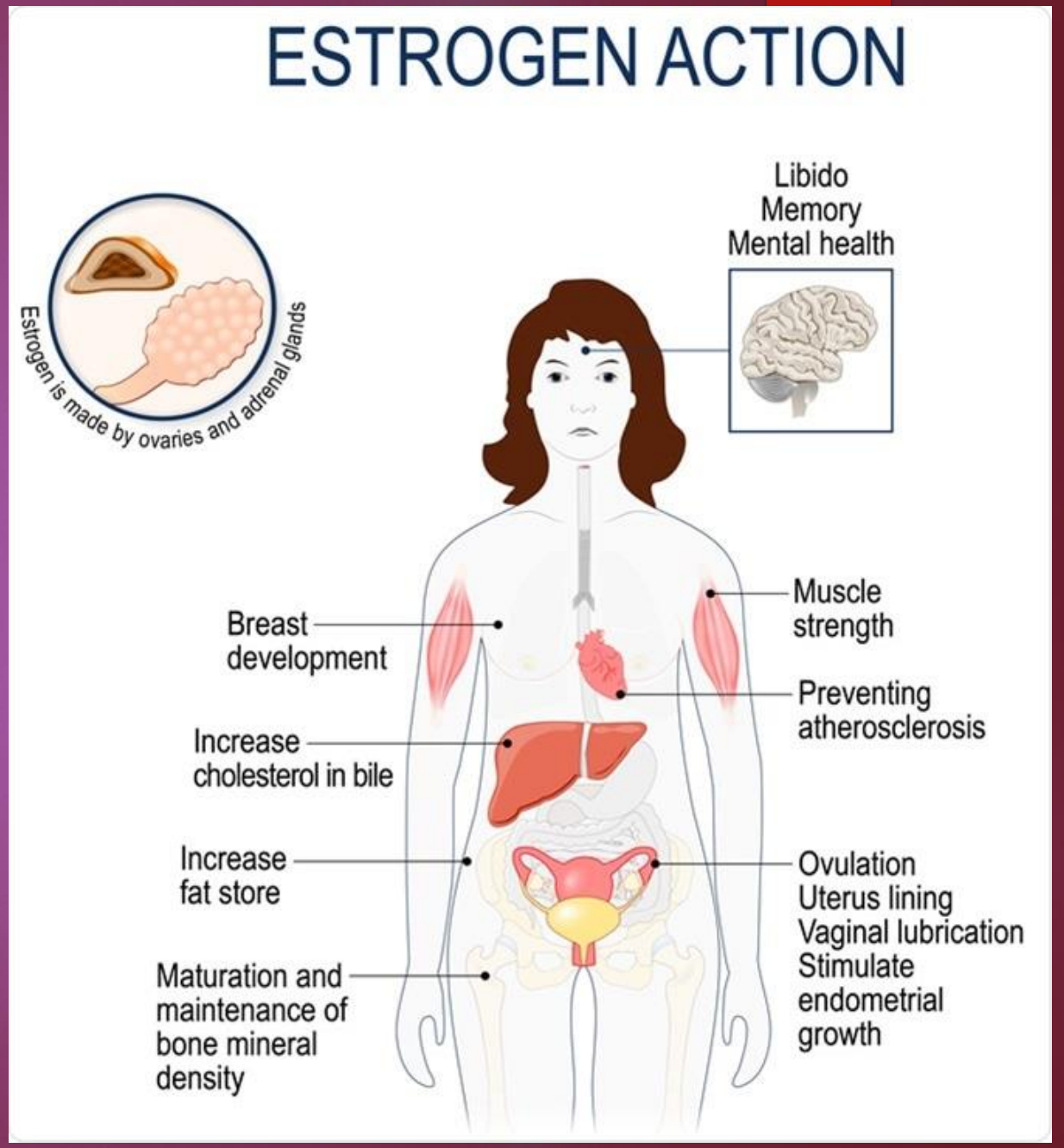
- **Testosterone**
- Production Site: testes (interstitial cells)
- Target Organ or Gland: entire body
- Male Reproductive System: Stimulates the development of the male reproductive tract and secondary sex characteristics
- Function in Female Reproductive System: Combined with estrogen, the female sex hormone, testosterone helps with the growth, maintenance, and repair of a woman's reproductive tissues, bone mass, and human behaviors.



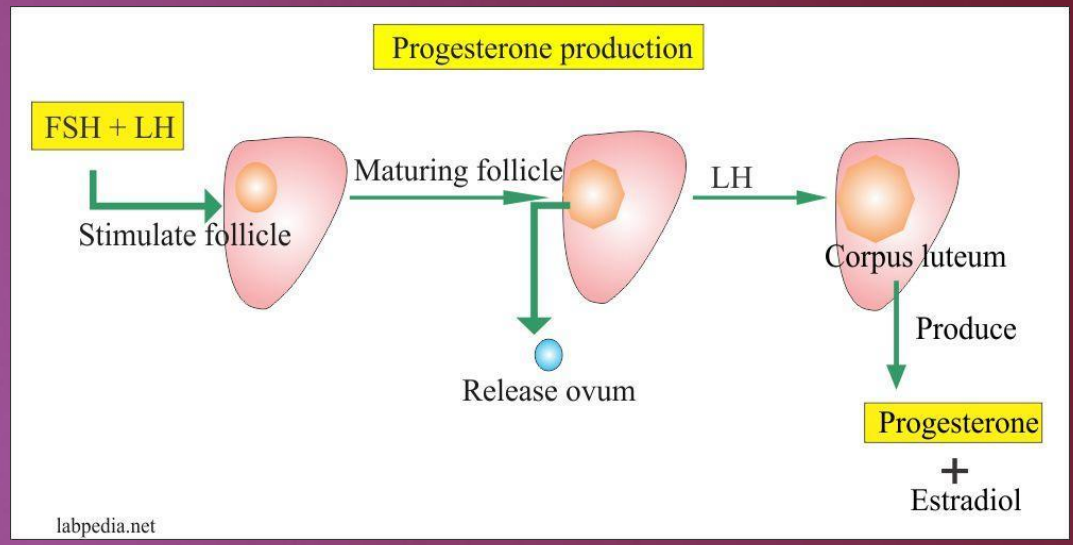
- **Inhibin**
- Production Site: Testes(Sertoli cells)
- Target Organ or Gland: anterior pituitary and hypothalamus
- Male Reproductive System: Inhibits FSH production
- Function in Female Reproductive System:  Inhibits FSH production



- **Estrogen**
- Production Site: ovary (follicle)
- Target Organ or Gland: anterior pituitary and hypothalamus
- Male Reproductive System: Inhibits FSH production
- Function in Female Reproductive System: Stimulates the development of the female reproductive tract and secondary sex characteristics

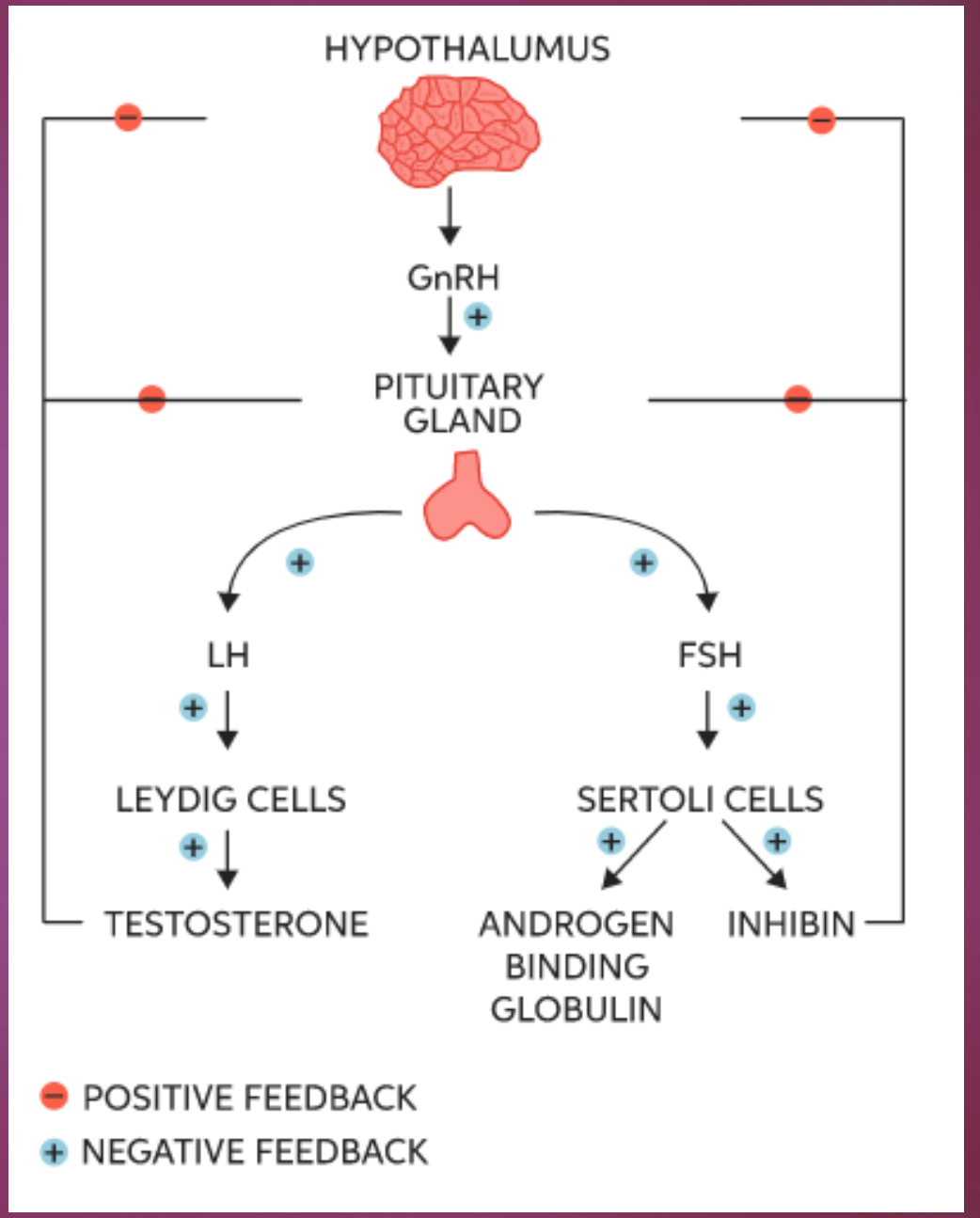


- **Progesterone**
- Production Site: ovary (corpus luteum) and adrenal glands and testes in men.
- Target Organ or Gland: Uterus
- Male Reproductive System: very little produced to help in production of testosterone.
- Function in Female Reproductive System: Causes uterine thickening

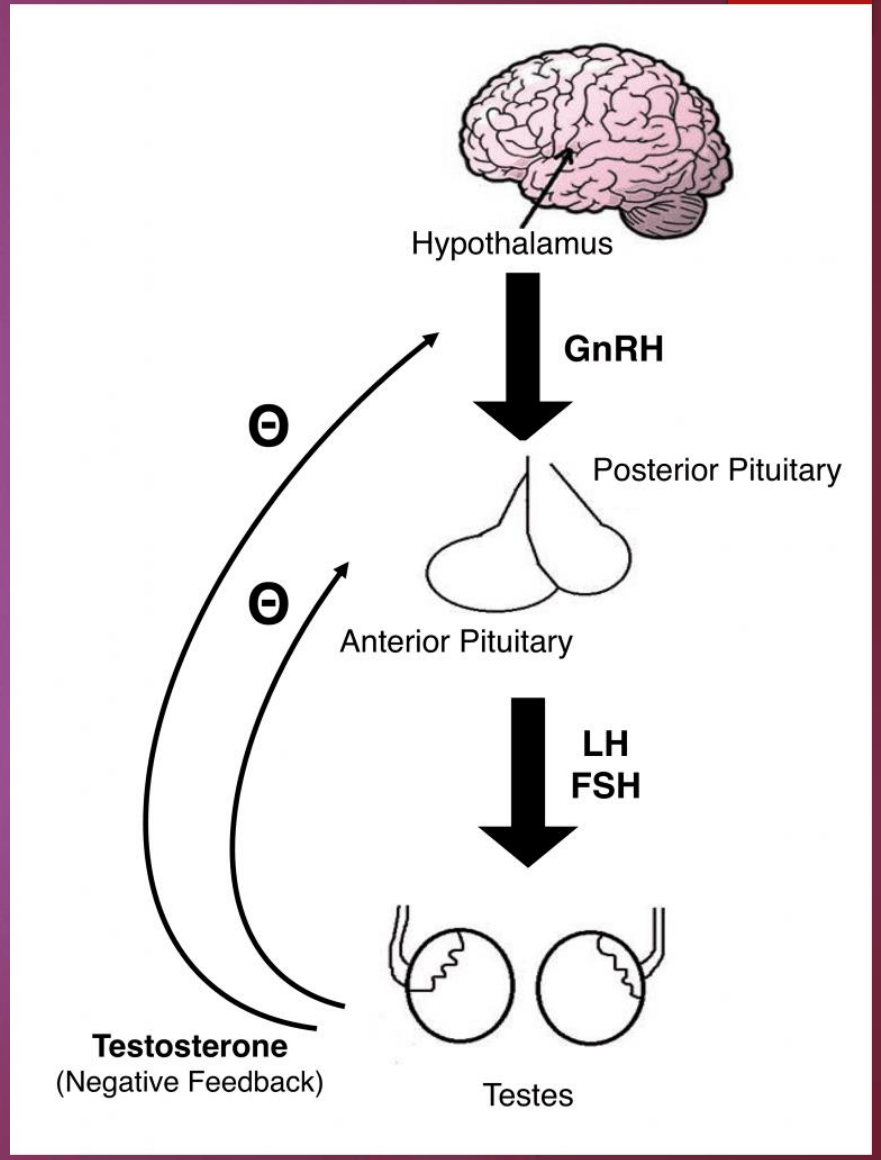


# Male Hormone Feedback

- Hormone feedback mechanisms control the process of spermatogenesis, and they maintain the secondary sexual characteristics.
- The release of GnRH from the hypothalamus triggers the release of FSH and LH from the anterior pituitary.
- FSH causes the interstitial cells in the testes to produce sperm.
- FSH causes cells in the seminiferous tubules (where sperm are produced) to release a hormone called inhibin.
- Inhibin acts on the anterior pituitary to inhibit the production of FSH.
- The result is a negative feedback loop. As the level of FSH drops, the testes release less inhibin.
- A decrease in the level of inhibin causes the anterior pituitary to release more FSH. This feedback loop keeps the level of sperm production relatively constant over time.

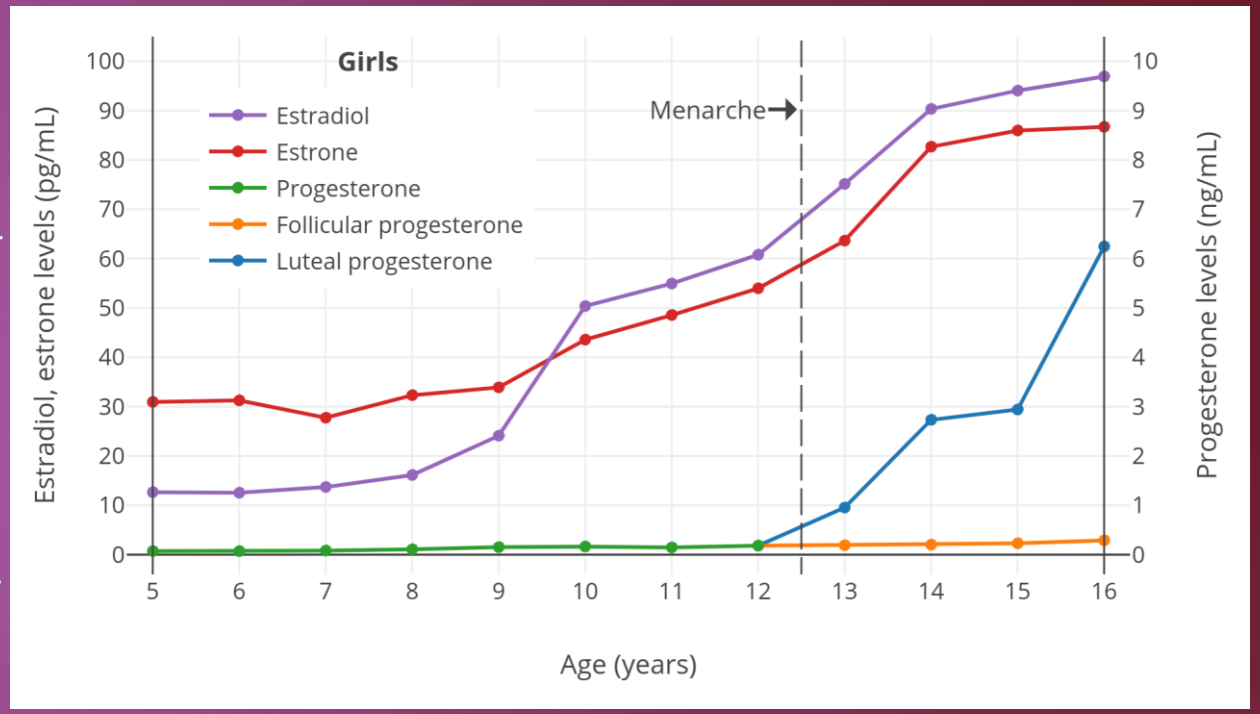

HYPOTHALUMUS
GnRH
PITUITARY GLAND
LH
FSH
LEYDIG CELLS
SERTOLI CELLS
TESTOSTERONE
ANDROGEN BINDING GLOBULIN
INHIBIN
POSITIVE FEEDBACK
NEGATIVE FEEDBACK

- A similar feedback loop maintains the secondary sex characteristics.
- LH causes the testes to release testosterone, which promotes changes such as muscle development and the formation of facial hair.
- As well, testosterone acts on the anterior pituitary to inhibit the release of LH.
- This feedback loop keeps the testosterone level relatively constant in the body.

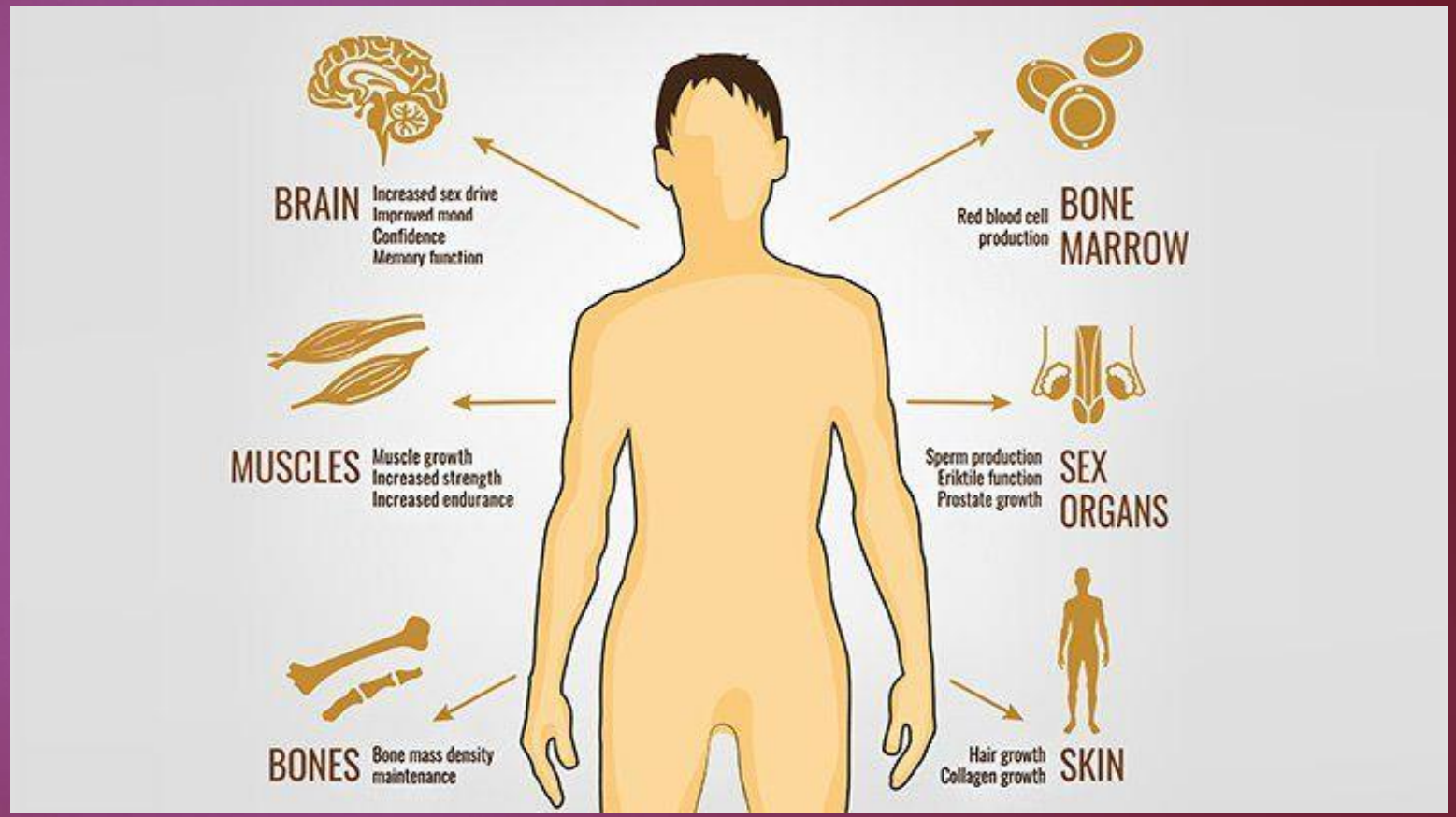


# Hormones and Puberty

- Early in puberty, levels of **luteinizing hormone** and **follicle-stimulating hormone increase**, stimulating the production of sex hormones.
- The increased levels of sex hormones (primarily estrogen) result in **physical changes**, including **maturation of the breasts, ovaries, uterus, and vagina.** Normally, these changes occur sequentially during puberty, resulting in sexual maturity.

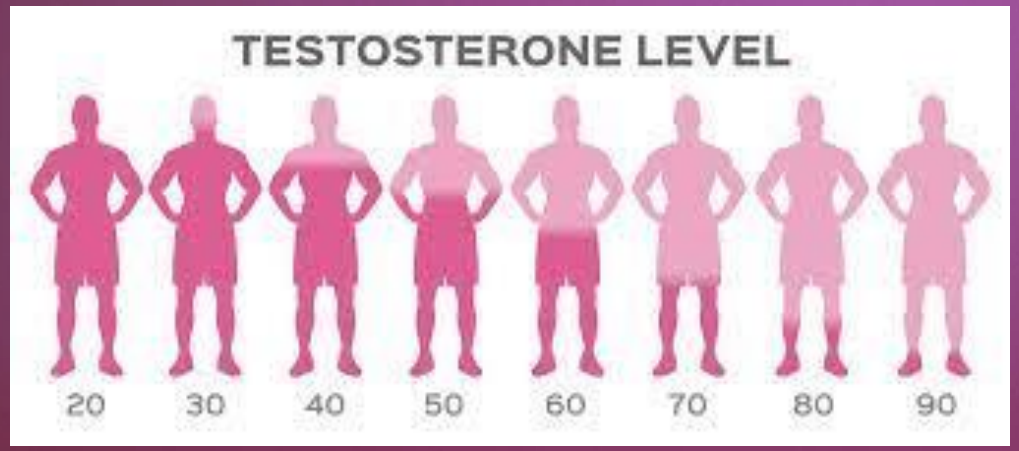


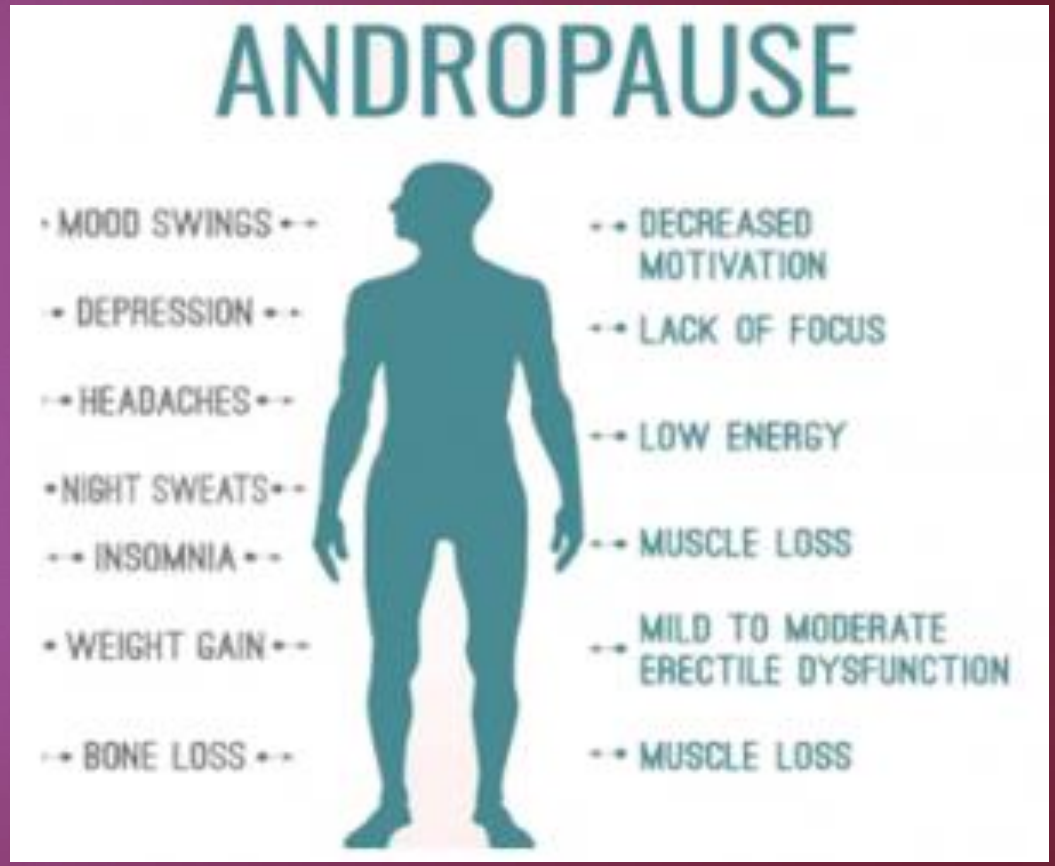
- In males, at puberty, the testes increase **testosterone** production. Testosterone causes reproductive organs to mature, muscle and bone to grow, facial and pubic hair to appear, and the voice to deepen.



# Hormones and Andropause

- "Andras" in Greek means human male and "pause" in Greek a cessation;
- **Andropause** is a syndrome associated with a decrease in sexual satisfaction or a decline in a feeling of general well-being with low levels of testosterone in older man.

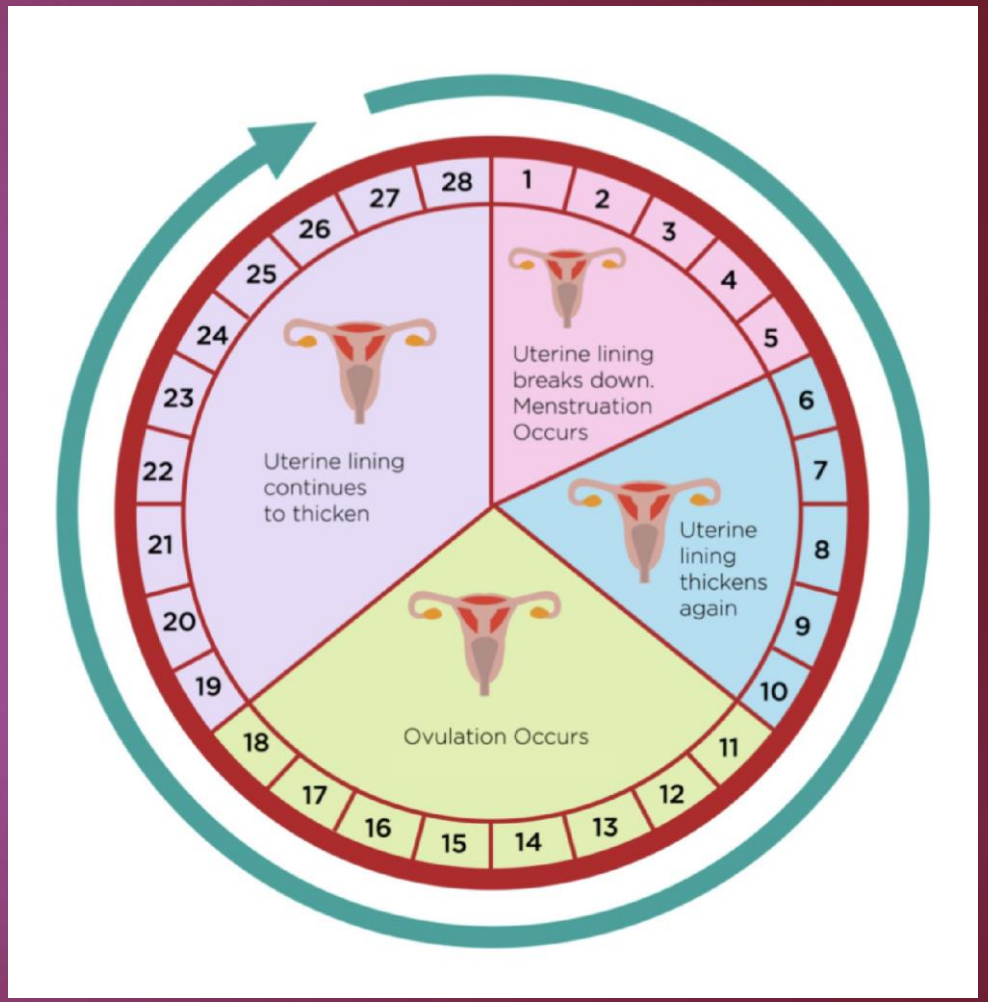


# Hormones and The Menstrual Cycle

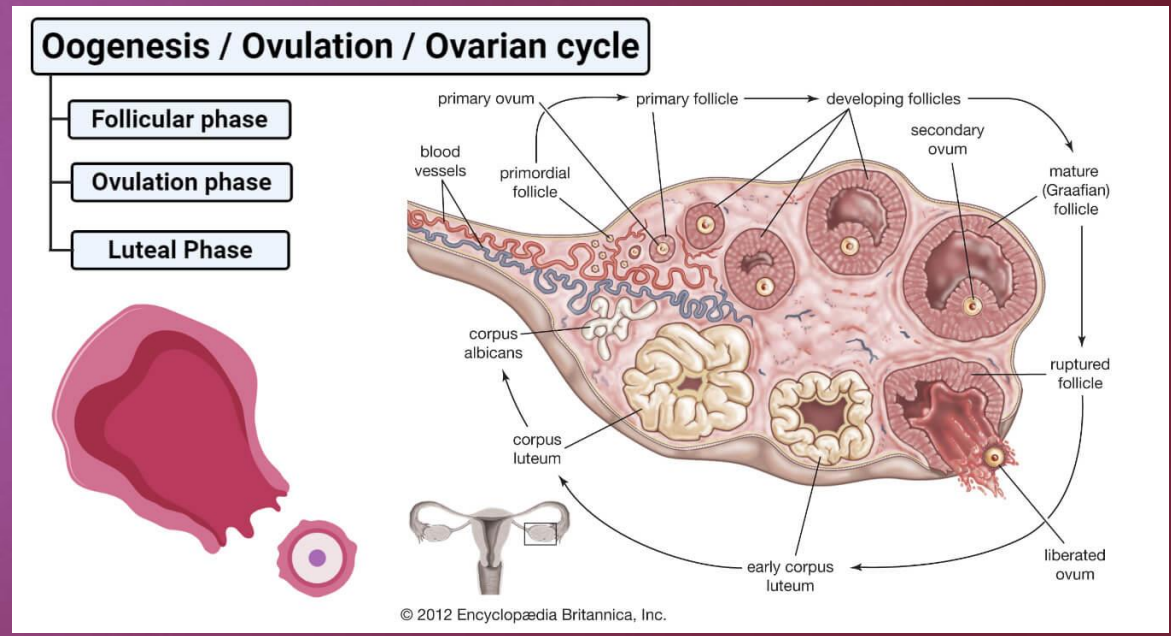
- A girl begins puberty when the hypothalamus increases its production of GnRH.
- This hormone acts on the anterior pituitary to trigger the release of LH and FSH.
- In girls, FSH and LH act on the ovaries to produce the female sex hormones estrogen and progesterone.
- These hormones stimulate the development of the female secondary sex characteristics and launch the menstrual cycle that will continue until about middle age.

- **menstrual cycle** 20- to 45-day cycle in which hormones stimulate development of the uterine lining and an ovum is released
- The menstrual cycle is usually about 28 days long, although it may vary considerably from one woman to the next, and even from one cycle to the next in the same woman.
- The cycle is said to begin with menstruation and end with the start of the next menstrual period.



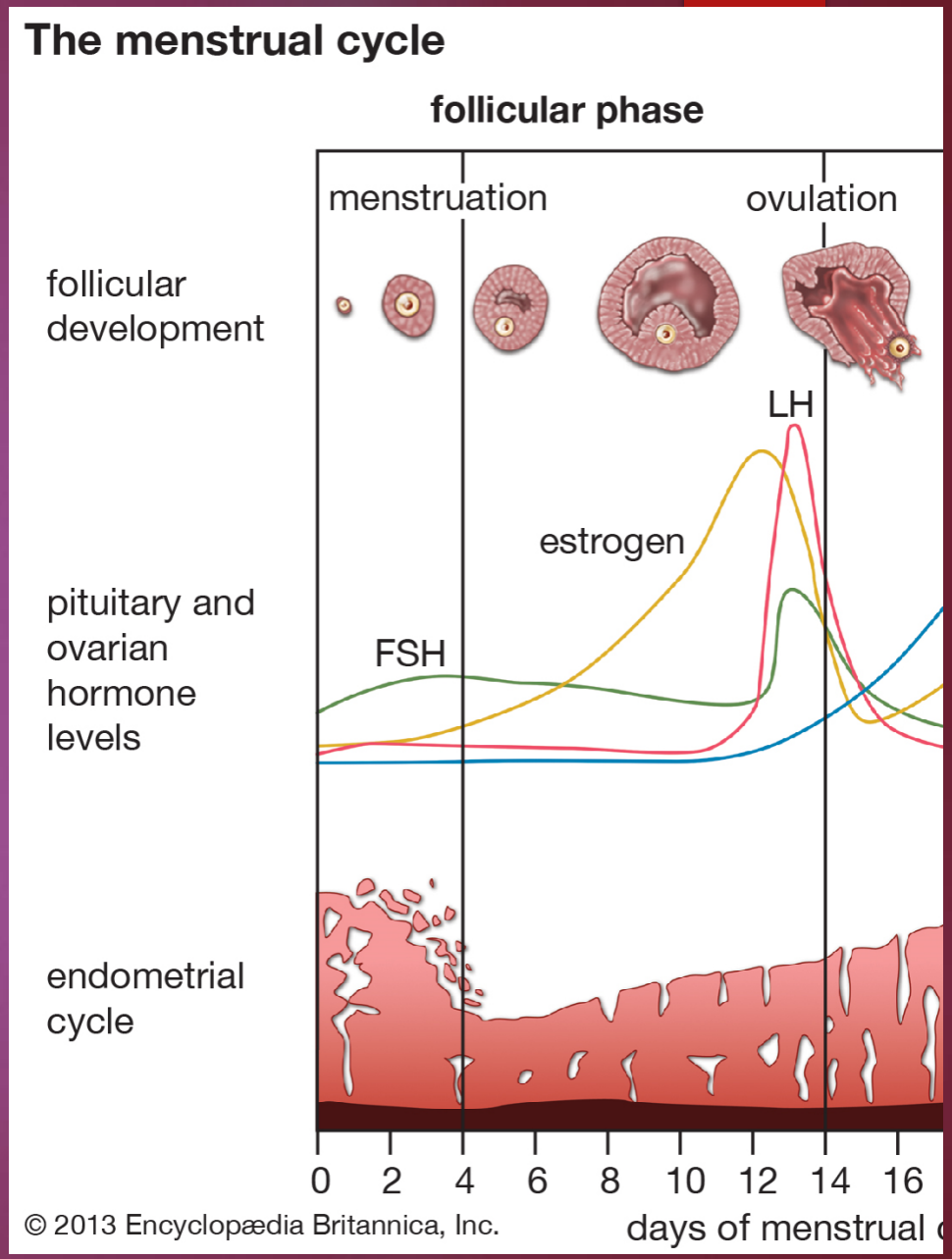
# The Ovarian Cycle

- Each follicle contains a single immature ovum.
- At birth, a baby girl has over **2,000,000** follicles.
- Many degenerate, leaving up to about **400,000** by puberty.
- During her lifetime, only approximately **400** of these follicles will mature to release an ovum.
- In a single ovarian cycle, one follicle matures, releases an ovum, and then develops into a yellowish, gland-like structure known as a corpus luteum.
- The corpus luteum then degenerates.



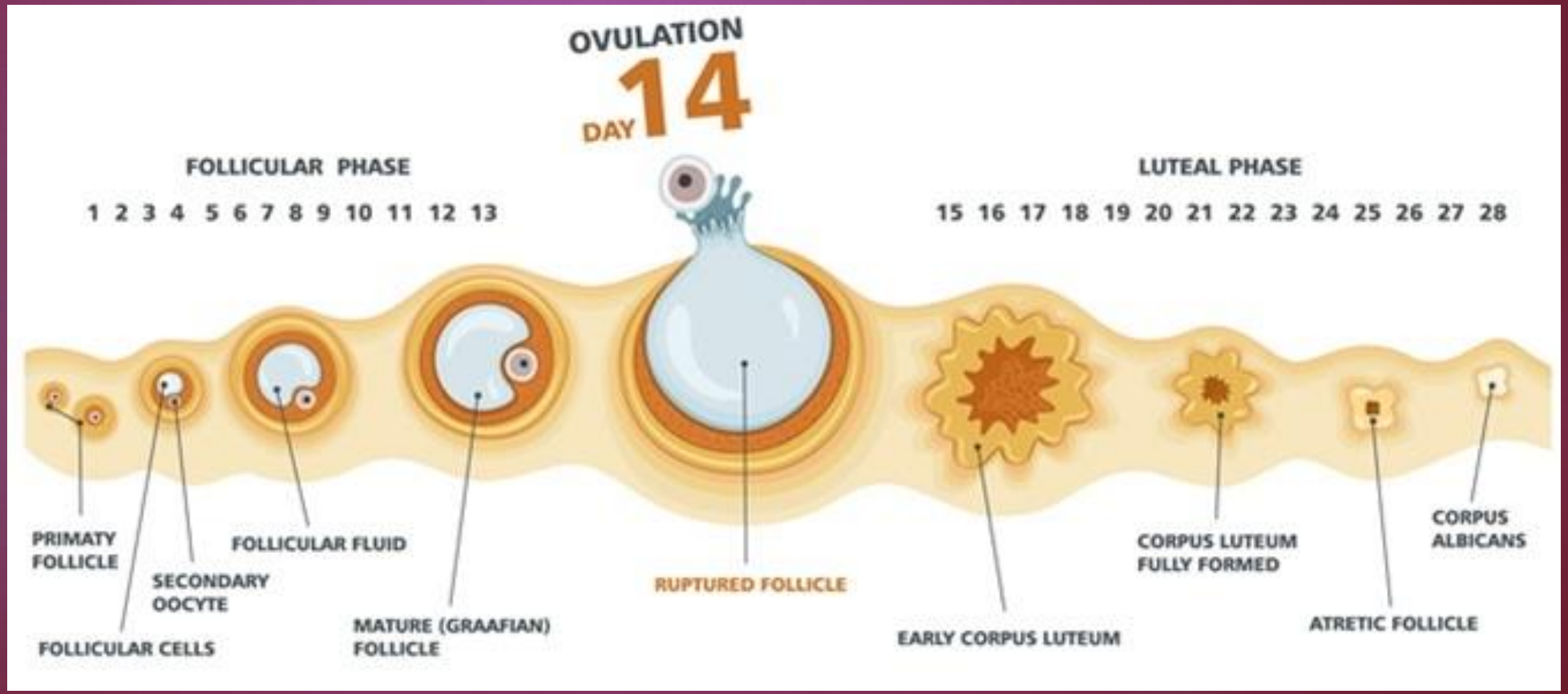
# Follicular Stage

- The first stage is known as the *follicular stage*. It begins with an increase in the level of FSH released by the anterior pituitary gland.
- FSH stimulates one follicle to mature.
- As the follicle matures, it releases estrogen and some progesterone.
- The rising level of estrogen in the blood acts on the anterior pituitary to inhibit the release of FSH.
- At the same time, the estrogen triggers a sudden release of GnRH from the hypothalamus.
- This leads to a sharp increase in LH production by the anterior pituitary triggering ovulation—the follicle bursts, releasing its ovum.



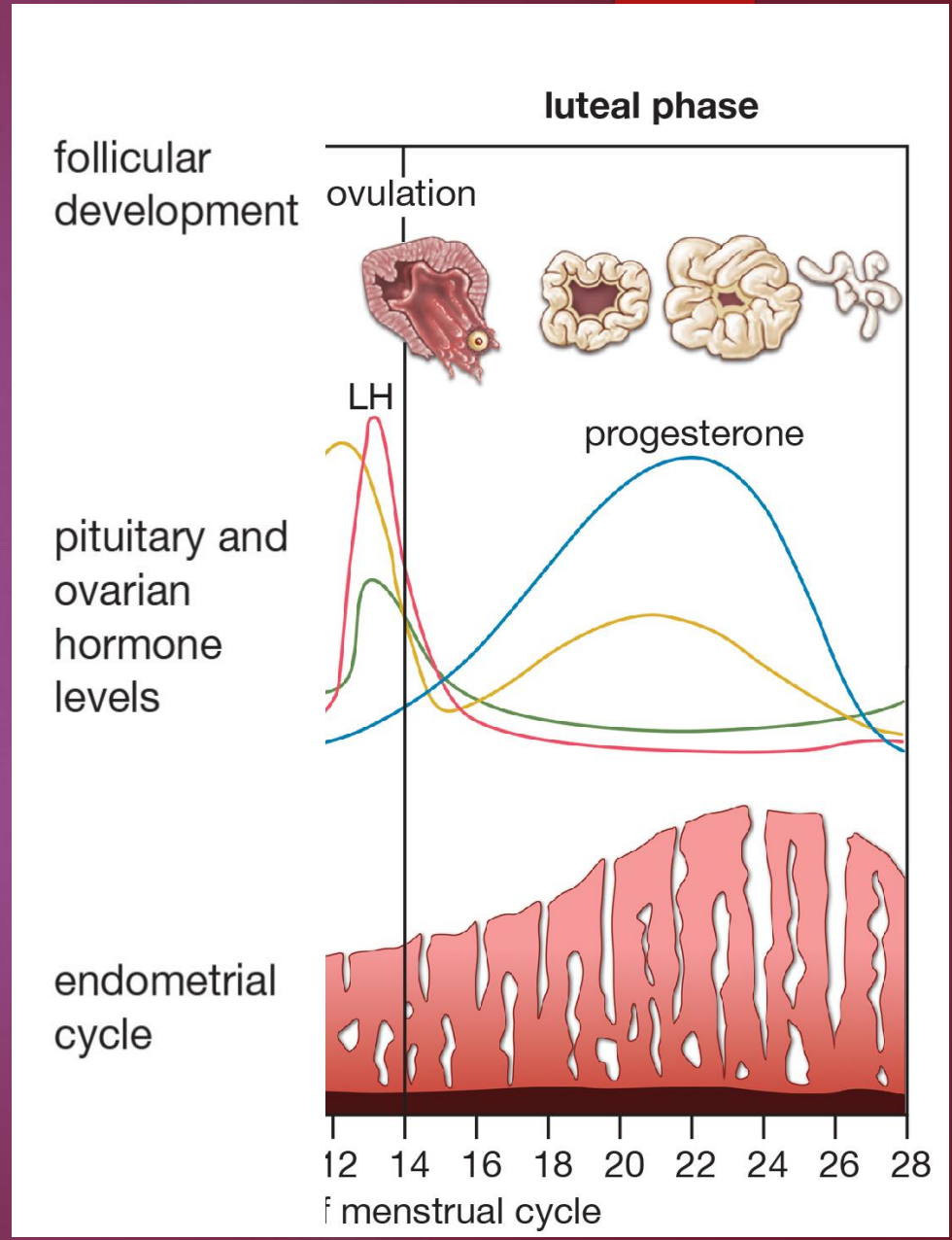
# Ovulation

- Ovulation marks the end of the follicular stage and the beginning of the second stage.
- Ovulation takes place about halfway through the ovarian cycle, around day 14.
- The ovum survives for up to 24 hours after ovulation.



# Luteal Stage

- The second stage is called the *luteal stage*. Once the ovum has been released, LH causes the follicle to develop into a corpus luteum.
- The corpus luteum secretes progesterone and some estrogen.
- As the levels of these hormones rise in the blood, they act on the anterior pituitary to inhibit FSH and LH production.
- The corpus luteum degenerates, leading to a decrease in the levels of estrogen and progesterone.
- The low levels of these sex hormones in the blood cause the anterior pituitary to increase its secretion of FSH, and the cycle begins again.



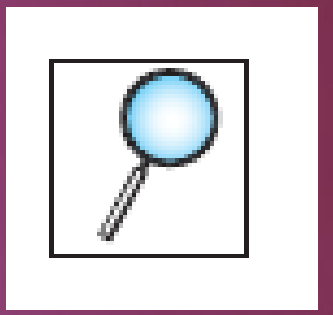
# Menstrual Cycle Lab

Investigation 13.B Menstrual Cycle Lab

Students are expected to analyze blood hormone data to infer associated physiological events in reproductive systems, including

the onset of puberty and andropause or menopause, and

ovarian and uterine events during the female menstrual cycle.



As part of these activities, students should

construct graphs from data (SCO 13.0),

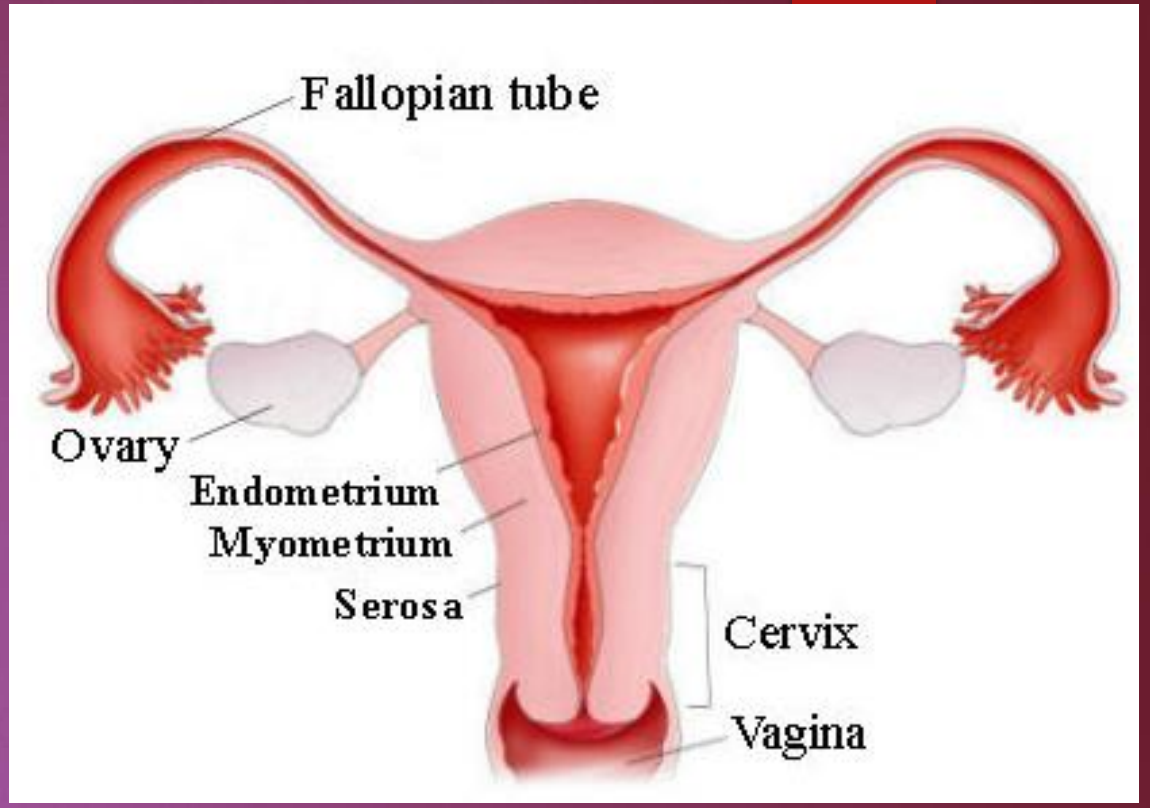
identify the line or curve of best fit and interpolate or extrapolate based on the line (SCO 14.0), and

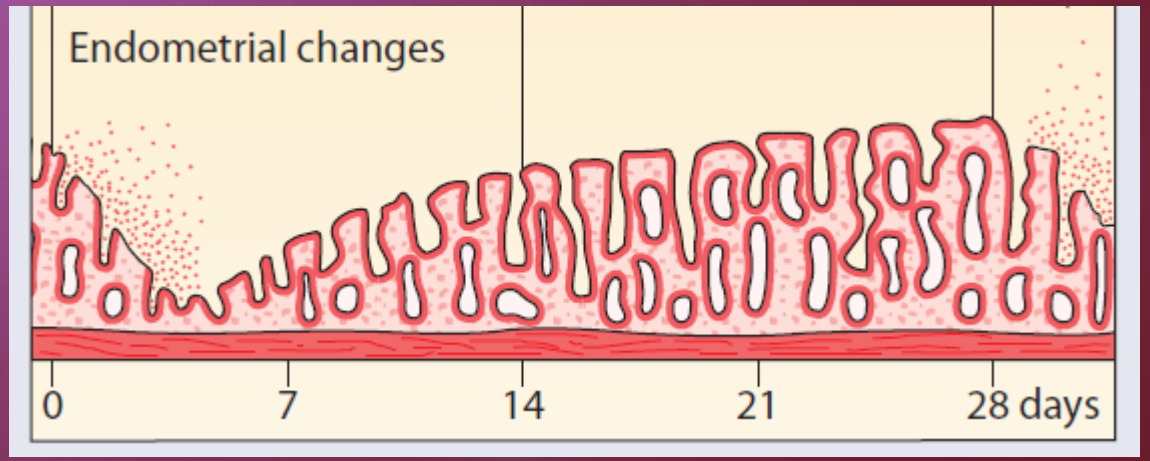
analyze graphs and tables and interpret patterns and trends in data and make inferences (SCO 15.0).

Refer to the *Integrated Skills* unit for elaboration of these skills. Activity 13.2 and Investigation 13.B (*NL Biology*, pp. 497 and 502) may help to address these expectations.

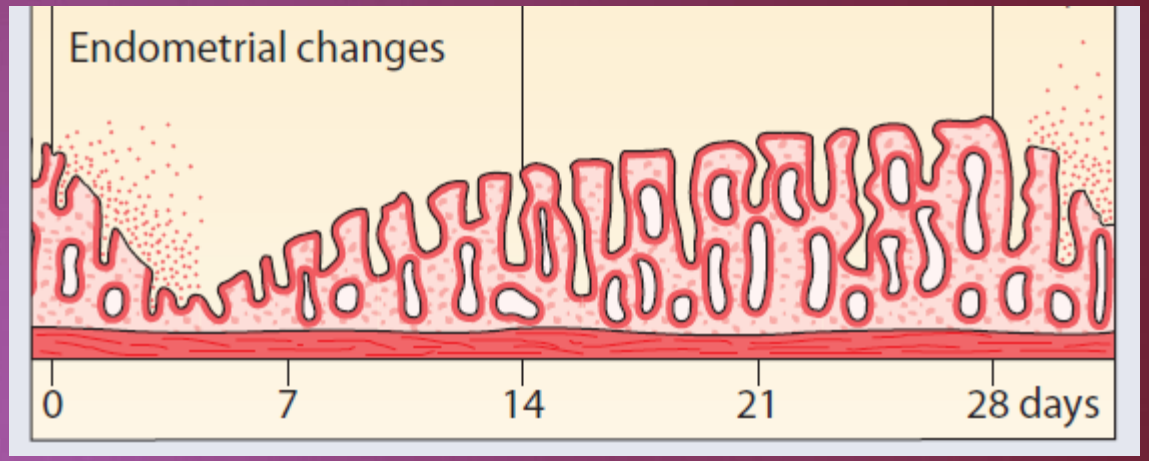
# The Uterine Cycle

- The uterine cycle begins on the first day of menstruation (which is also the first day of the ovarian cycle).
- On this day, the corpus luteum has degenerated and the levels of the sex hormones in the blood are low.
- As a new follicle begins to mature and release estrogen, the level of estrogen in the blood gradually increases.
- Beginning around the sixth day of the uterine cycle, the estrogen level is high enough to cause the endometrium to begin thickening.



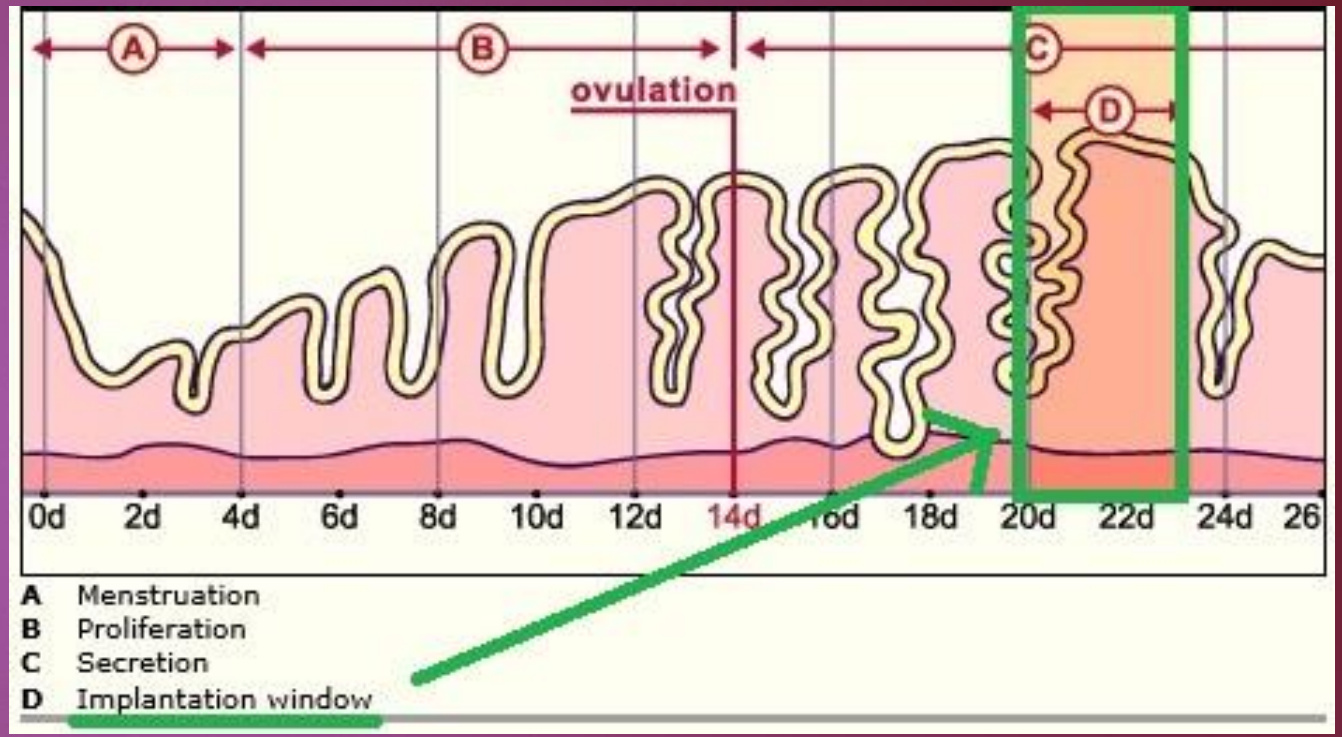



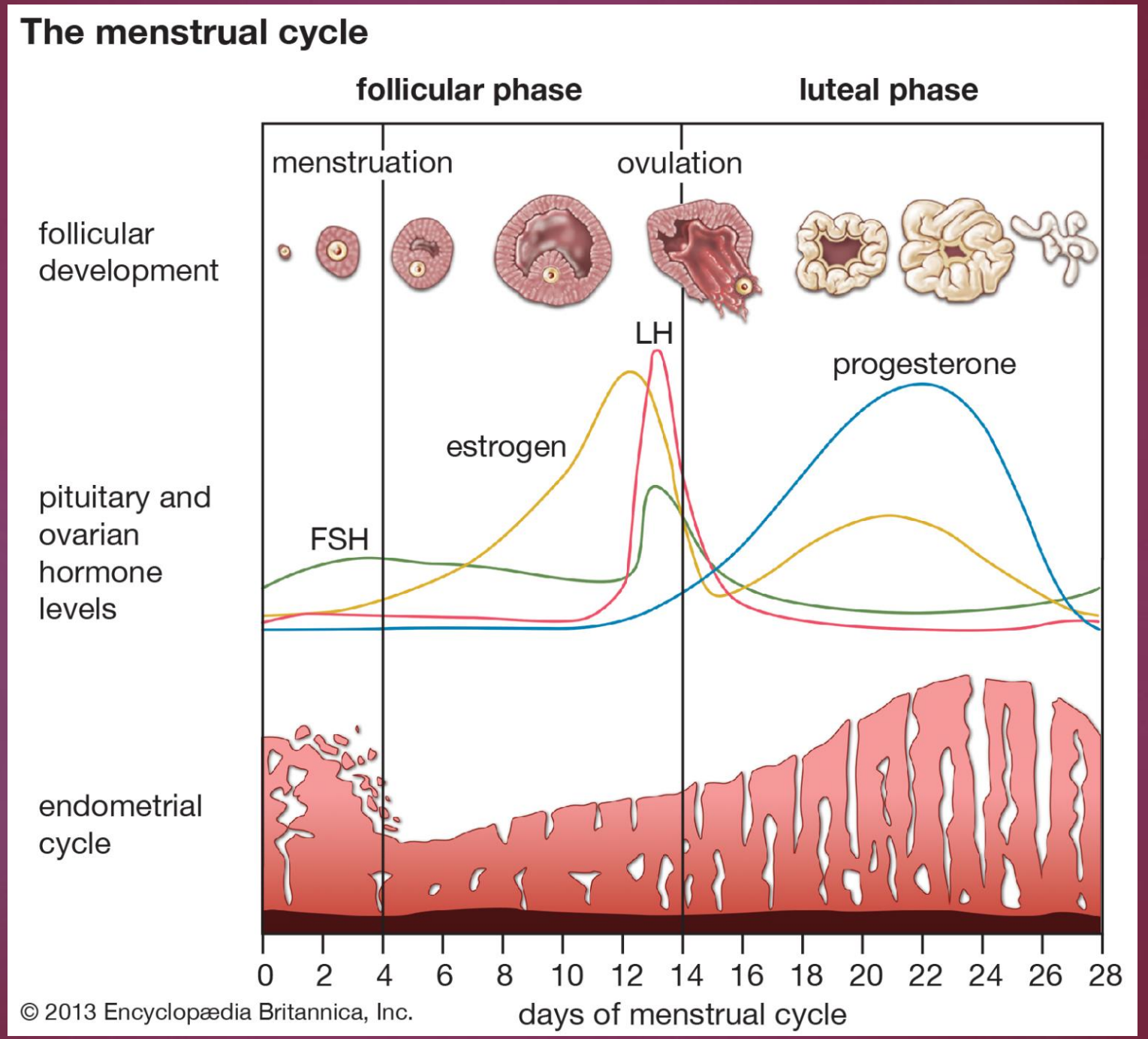
- After ovulation, the release of progesterone by the corpus luteum causes a more rapid thickening of the endometrium.
- Between days 15 and 23 of the cycle, the thickness of the endometrium may double or even triple.
- **If fertilization does not occur,** the corpus luteum degenerates. The levels of the sex hormones drop, the endometrium breaks down, and menstruation begins again.



# The Uterine Cycle

- **If fertilization occurs,** the fertilized egg completes the passage through the oviduct and arrives at the uterus a few days later.
- The timing of the uterine cycle ensures that the uterus is prepared to receive and nurture a new life.
- The events of the uterine cycle cause a buildup of blood vessels and tissues in the endometrium.




The menstrual cycle
follicular phase
luteal phase
menstruation
ovulation
follicular development
LH
progesterone
estrogen
pituitary and ovarian hormone levels
FSH
endometrial cycle
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
days of menstrual cycle
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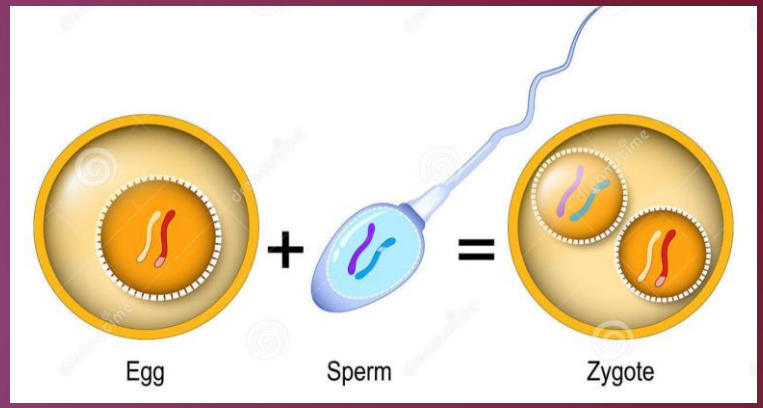
# Embryonic Development

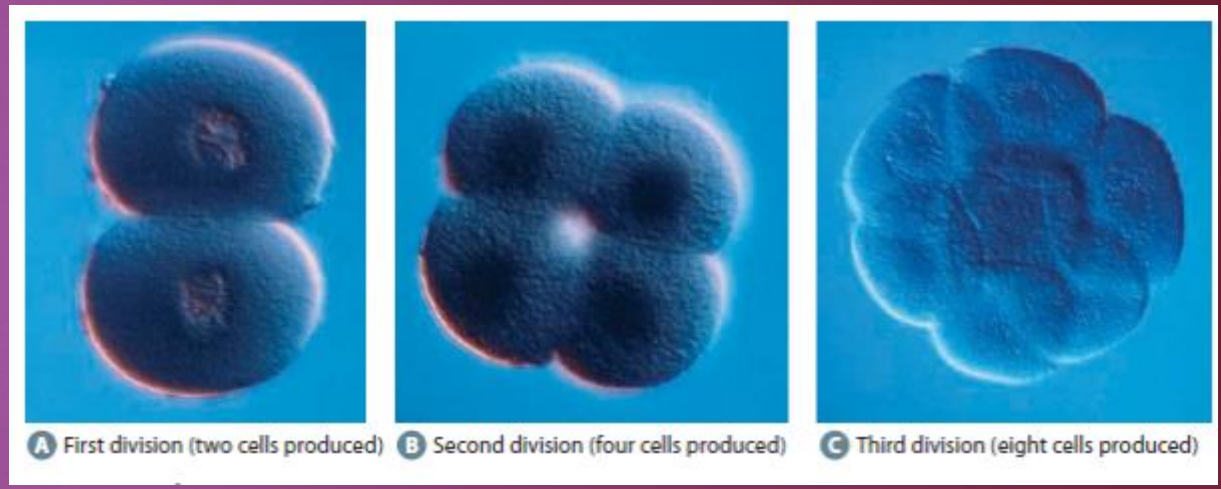
- **fertilization** joining of a male and a female gamete
- An egg is released from an ovary and swept into an oviduct.
- The egg is carried toward the uterus by muscular contractions and the wavelike actions of cilia, which line the walls of the oviduct.
- It takes about four days to reach the uterus.
- It must be fertilized, however, within 12 to 24 h of its release, or it will lose its capacity to develop further.
- For a sperm and egg to join, the sperm must reach the egg during the early part of its movement through the oviduct.

**zygote** cell formed by the union of two gametes

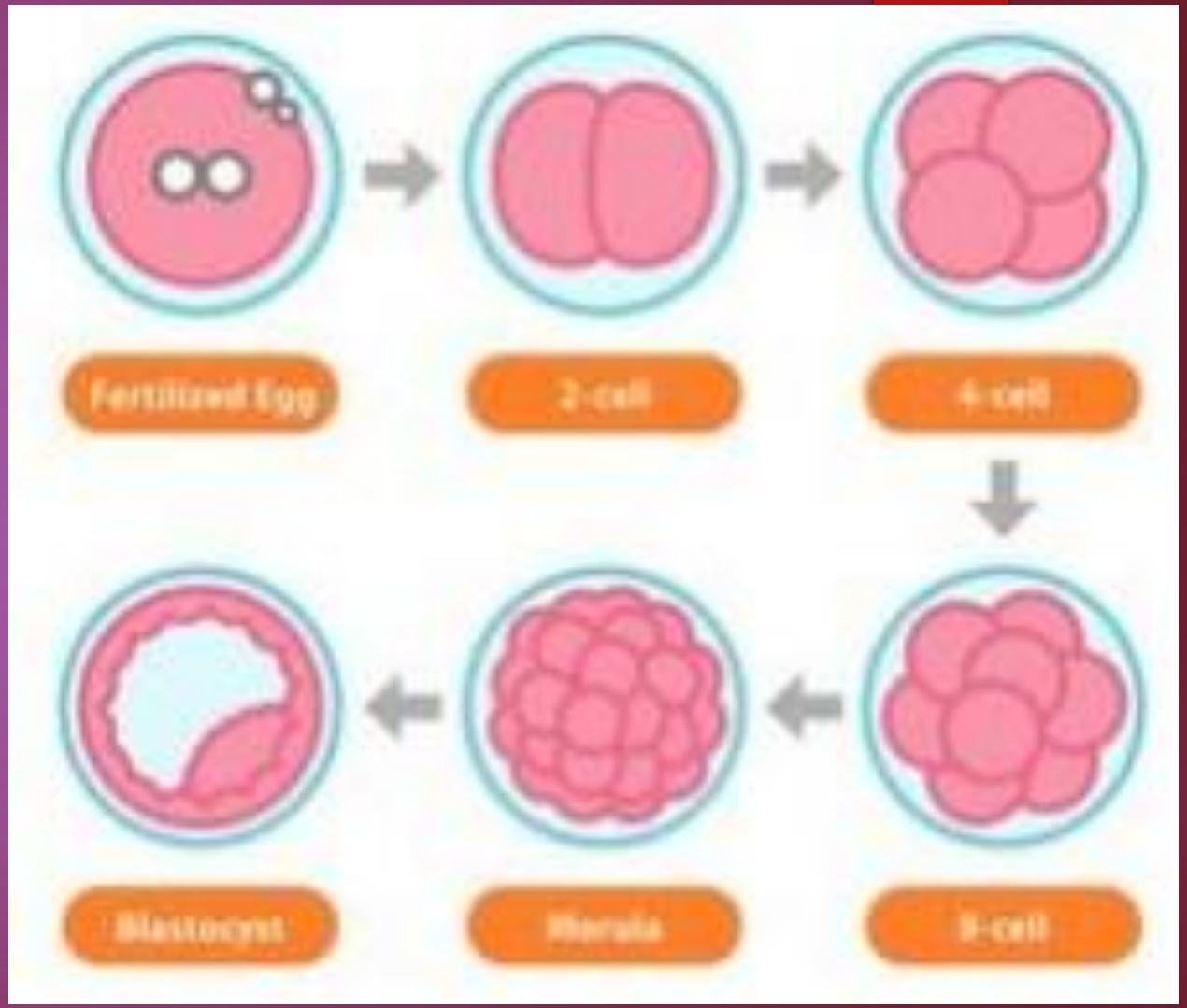


# Cleavage/Morula/Blastocyst

- Within 30 h of being fertilized, the 0.1 mm zygote divides by mitosis for the first time, giving rise to two new cells.
- These cells also divide, forming four cells. The four cells, in turn, divide to form eight cells, and so on. This process of cell division occurs quickly, with little time for the individual cells to grow. As a result, the cells become smaller and smaller with each division. The overall size of the zygote, however, remains about 0.1 mm.
- **Cleavage** process of cell division without growth

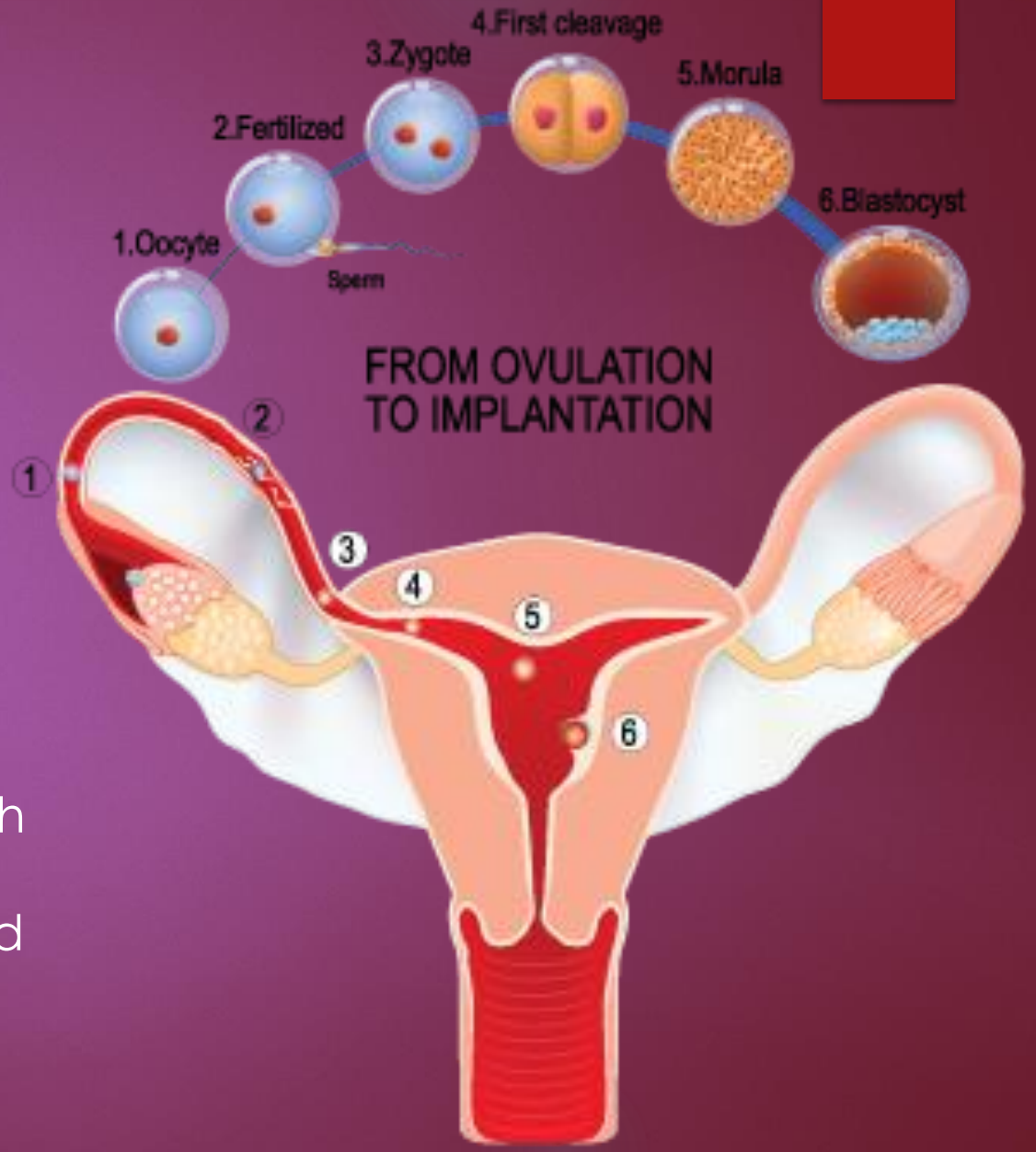


- **morula** is an early-stage embryo consisting of 16 cells (called blastomeres) in a solid ball.
- **blastocyst** embryo at the stage of implantation; consists of the trophoblast and inner cell mass
- One group of cells, called the ***trophoblast*** (meaning "nourishment of the germ"), forms the outer layer of the blastocyst.

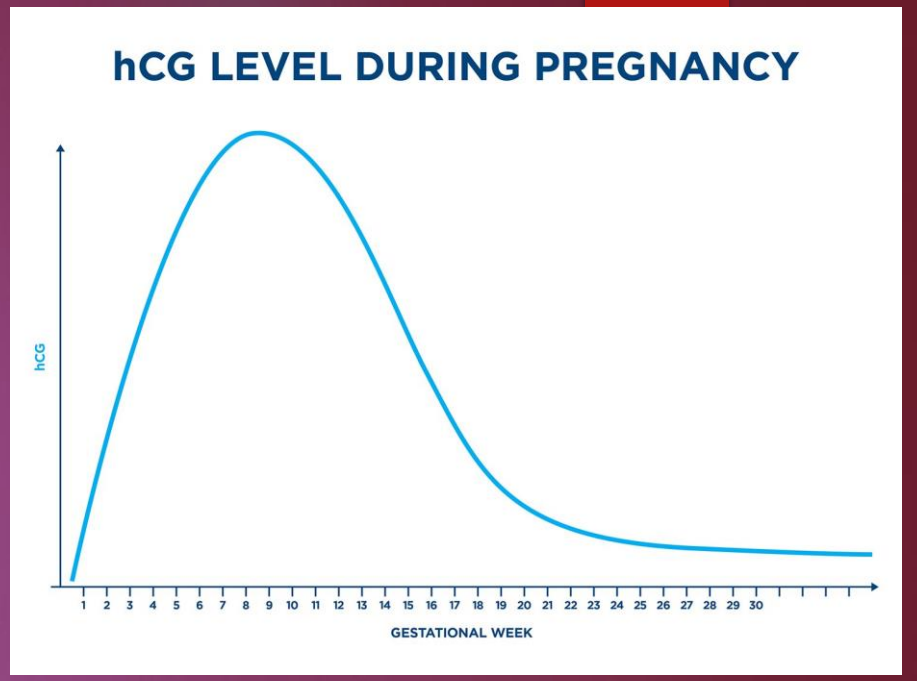


# Implantation

- **implantation** attachment of the blastocyst to the endometrium
- Between the fifth and seventh day after fertilization, the blastocyst attaches to the endometrium.
- The trophoblast cells secrete enzymes that digest some of the tissues and blood vessels of the endometrium, and the blastocyst slowly sinks into the uterine wall.
- Implantation is complete by the 10th to 14th day. With successful implantation, the woman is now said to be pregnant.

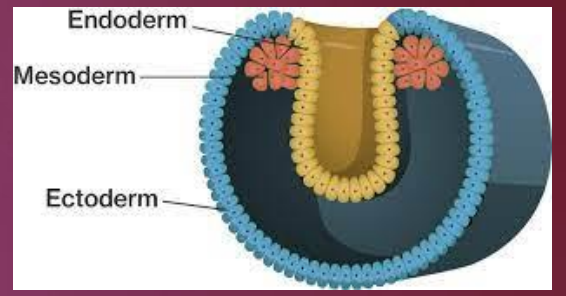


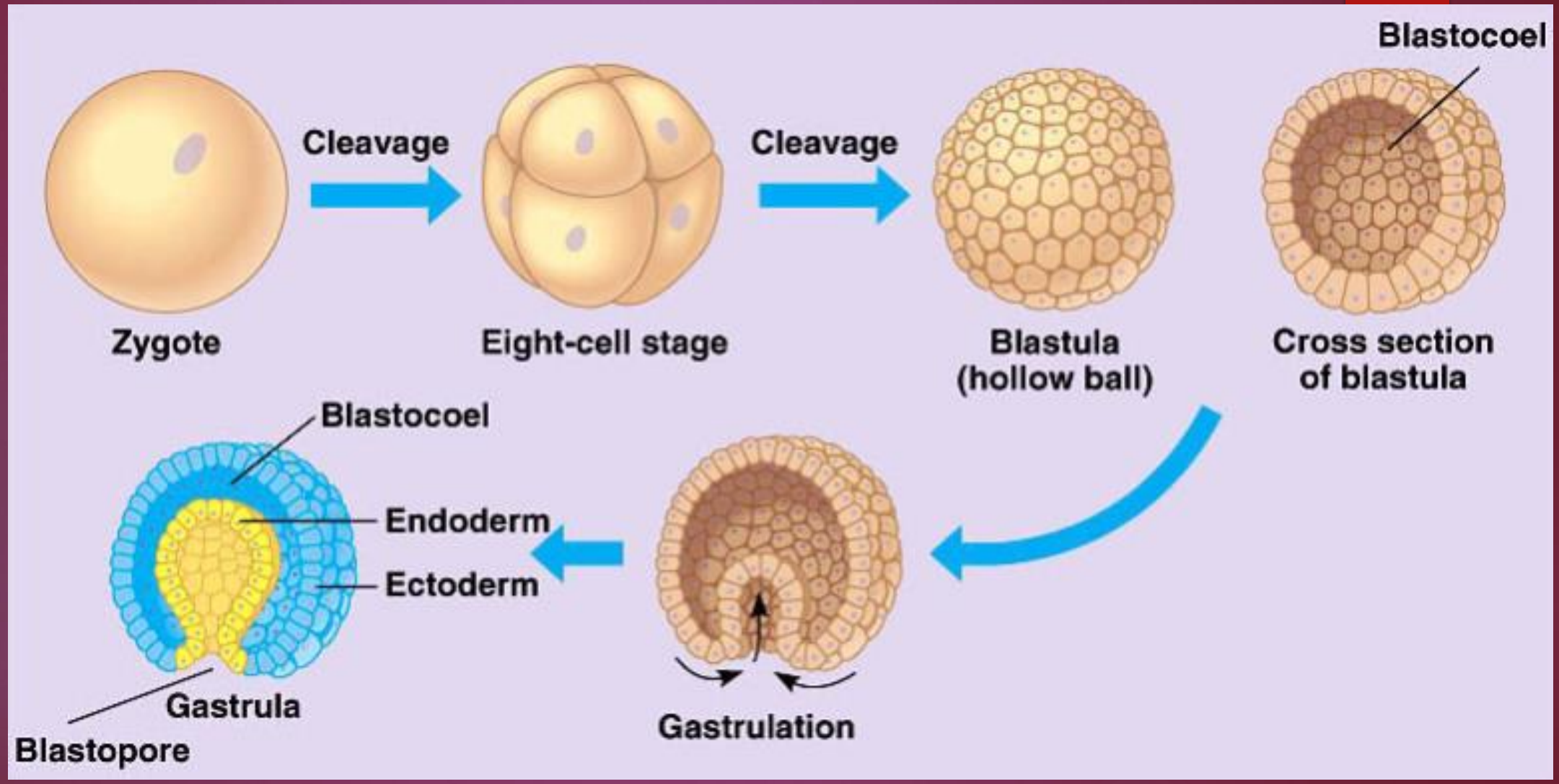
- **human chorionic gonadotropin (hCG)** hormone secreted by the trophoblast during implantation
- hCG has the same effects as luteinizing hormone (LH), so it maintains the corpus luteum past the time when it would otherwise degenerate.
- As a result, the secretion of estrogen and progesterone continues, maintaining the endometrium and preventing menstruation.
- The secretion of hCG continues at a high level for about two months.
- After four months the placenta secretes sufficient estrogen and progesterone to maintain the endometrium.




# Gastrulation

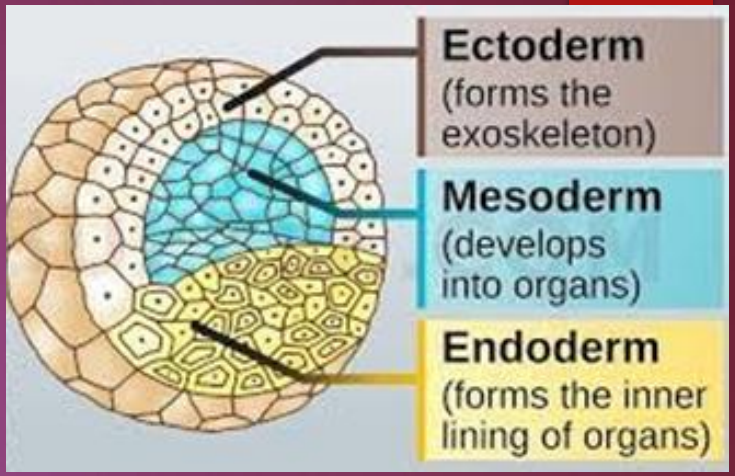
- **gastrulation** formation of the three primary germ layers
- As the blastocyst continues and completes the process of implantation, the inner cell mass changes. A space begins to form between the inner cell mass and the trophoblast.
- This space, called the amniotic cavity, will soon fill with fluid and is the place where the baby will develop.
- As the amniotic cavity forms, the inner cell mass flattens into a disk-shaped structure called the *embryonic disk*.
- The embryonic disk consists of two layers: an outer ***ectoderm***, which is closer to the amniotic cavity, and an inner ***endoderm***. Shortly after, a third layer, called the ***mesoderm***, forms between the endoderm and the ectoderm.
- **Gastrula** an embryo at the stage following the blastula, when it is a hollow cup-shaped structure having three layers of cells.

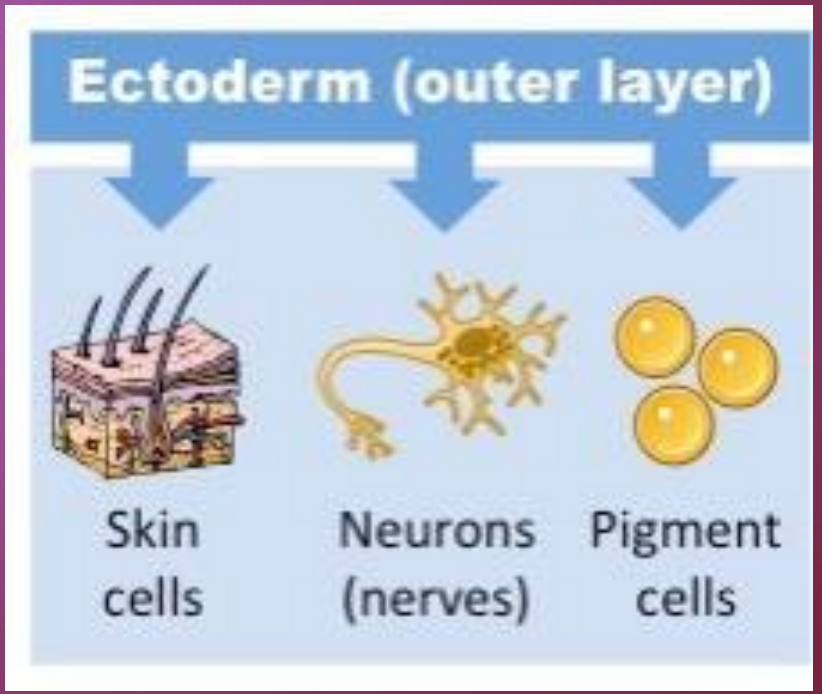



Blastocoel
Cleavage
Cleavage
Zygote
Eight-cell stage
Blastula
(hollow ball)
Cross section
of blastula
Blastocoel
Endoderm
Ectoderm
Gastrula
Blastopore
Gastrulation

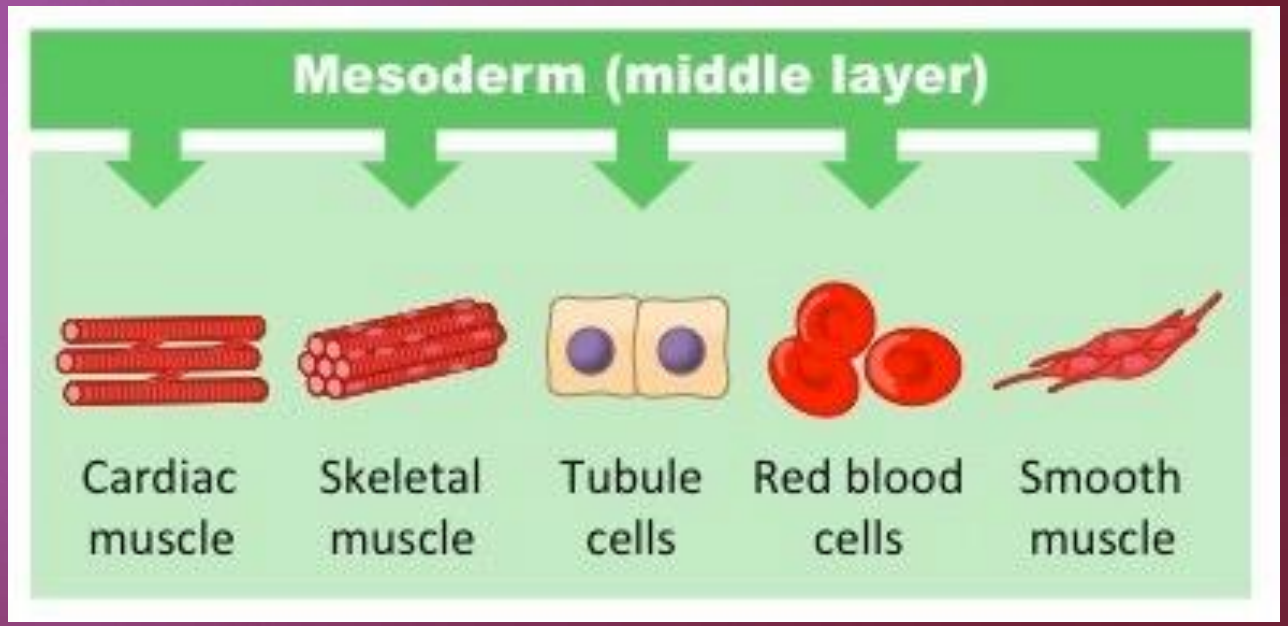
# Primary Germ Layers

- **Ectoderm (Outer Primary Germ Layer)**
- outer skin (epidermis) and associated structures (hair, nails, sweat glands, mammary glands)
- nervous tissue and sense organs
- pituitary gland
- tooth enamel
- adrenal medulla
- eye lens

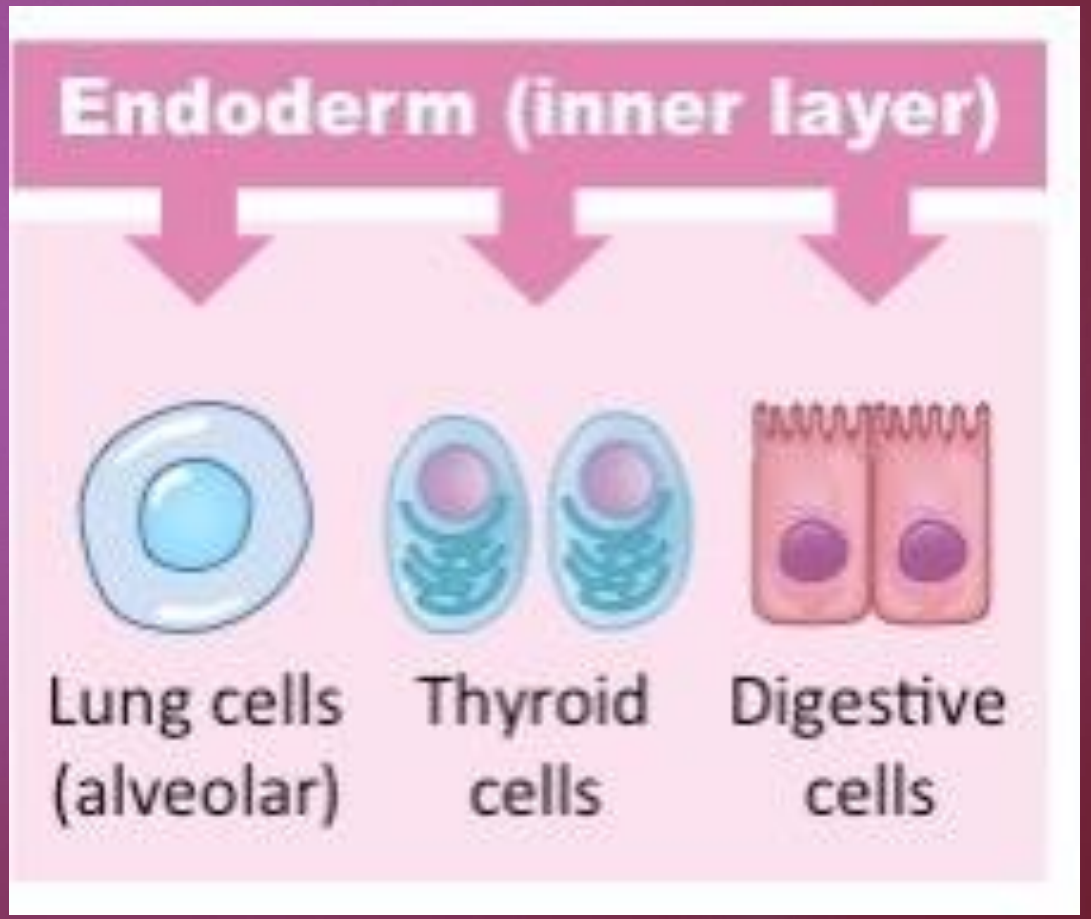


- **Mesoderm (Middle Primary Germ Layer)**
- dermis of skin
- cellular lining of blood vessels, lymphatic vessels, body cavities
- muscle tissue
- connective tissue (including bone, cartilage, blood)
- adrenal cortex
- kidneys and ureters
- Heart
- Spleen
- internal reproductive organs

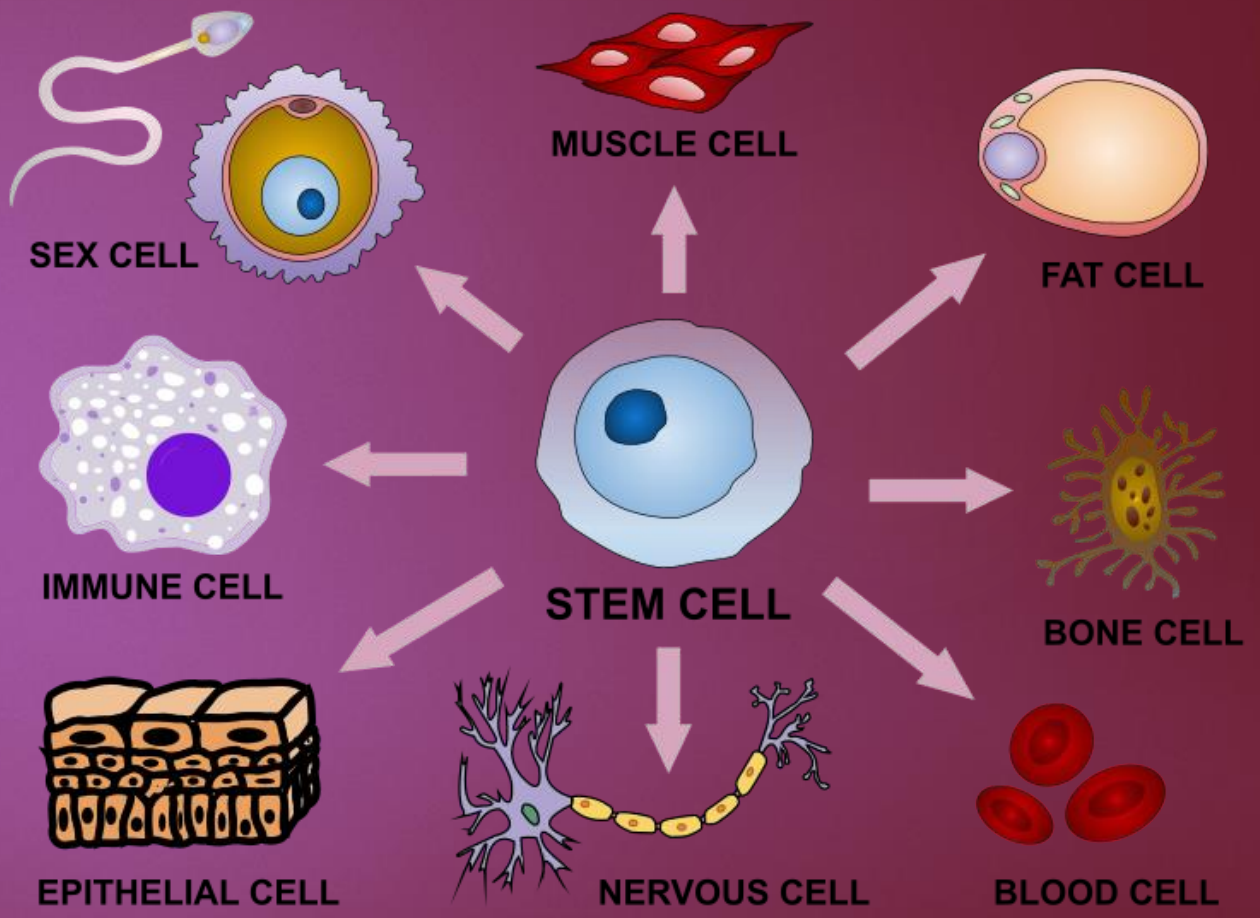


- **Endoderm (Inner Primary Germ Layer)**
- cellular lining of respiratory tract, digestive tract, urinary bladder, urethra
- liver (most)
- tonsils (partial)
- gall bladder
- parathyroid glands
- Pancreas
- thyroid glands
- thymus



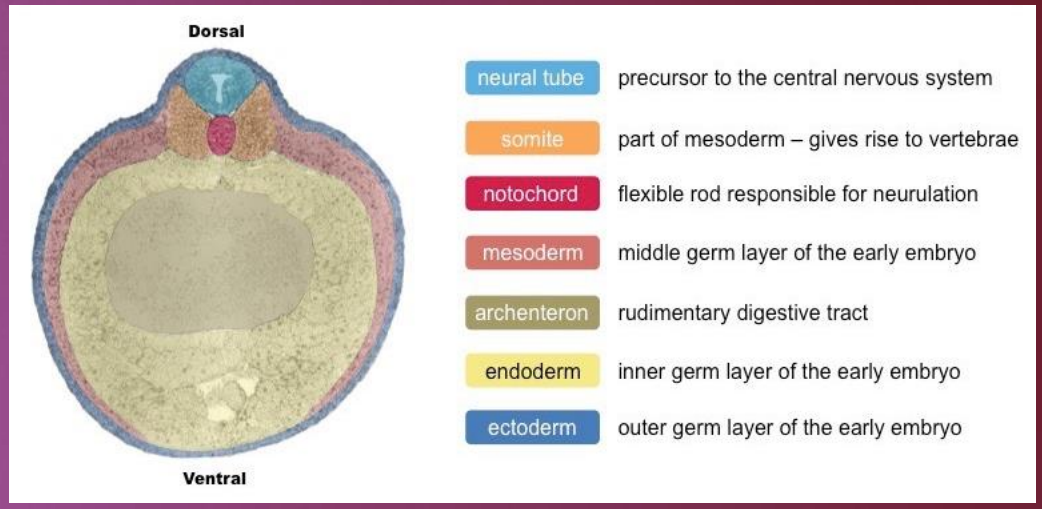
# Morphogenesis

- **Morphogenesis** the series of events that form distinct structures of the developing organism.
- Morphogenesis depends on the ability of early embryonic cells to become different types of cells.
- **differentiation** process that allows specialization of cell function



# Neurulation and Organ Formation

- **neurulation** process of forming the neural tube
- During the third week, a thickened band of mesoderm cells develops along the back of the embryonic disk. These cells lie along what will become the baby's back and come together to form a rod-like structure called the notochord.
- The notochord will form the basic framework of the skeleton.
- The nervous system develops from ectoderm that is located just above the notochord.
- First, cells along the surface above the notochord begin to thicken. Folds develop on each side of a groove along this surface.
- When the folds fuse, they become a tube, called the neural tube, which develops into the brain and spinal cord.



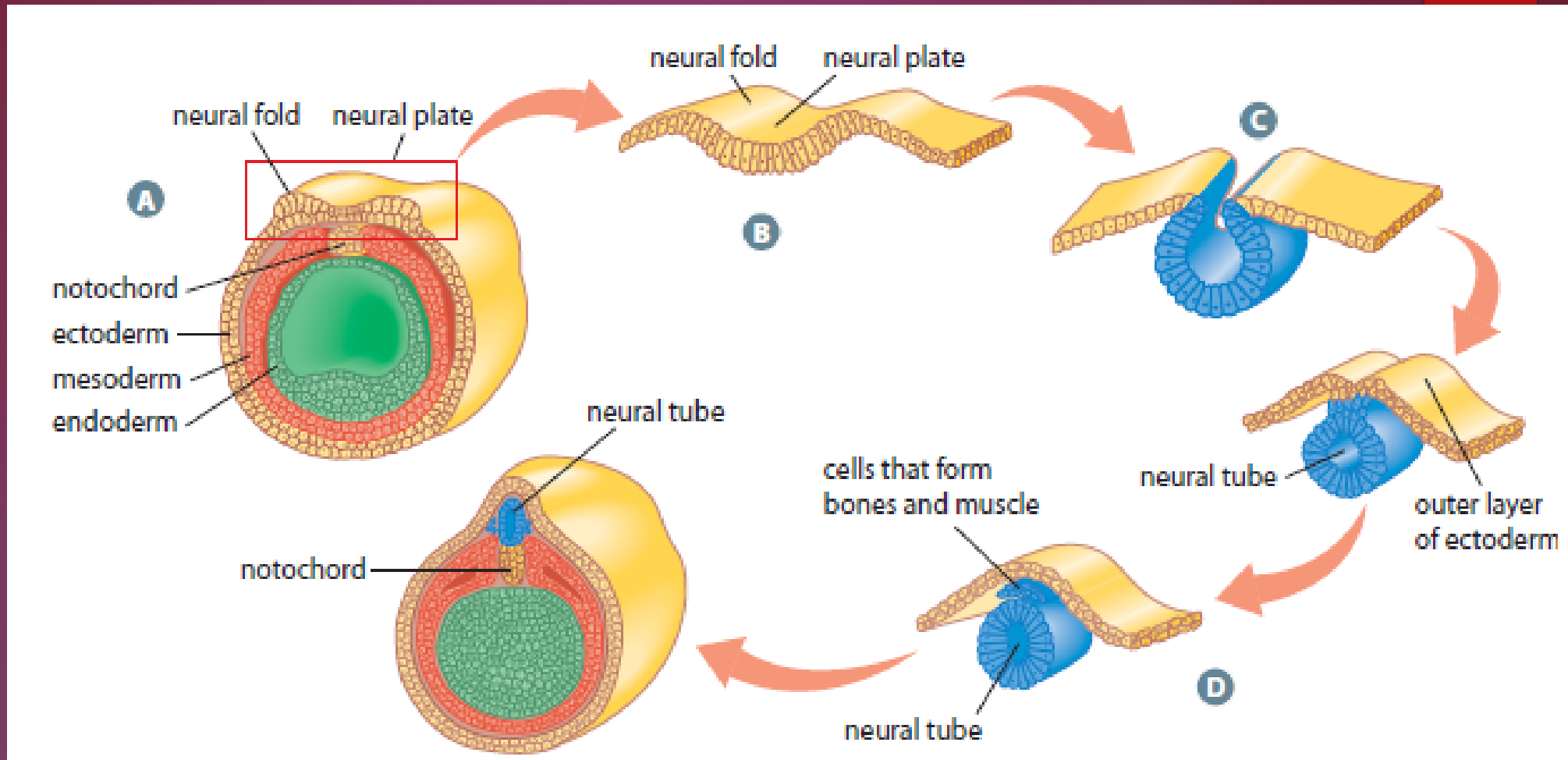
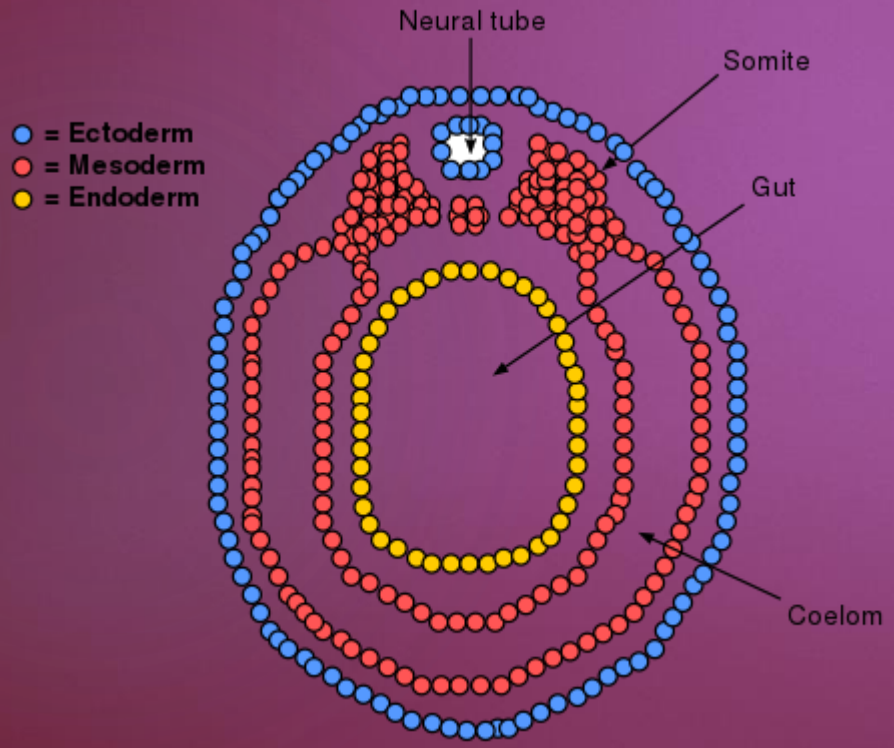
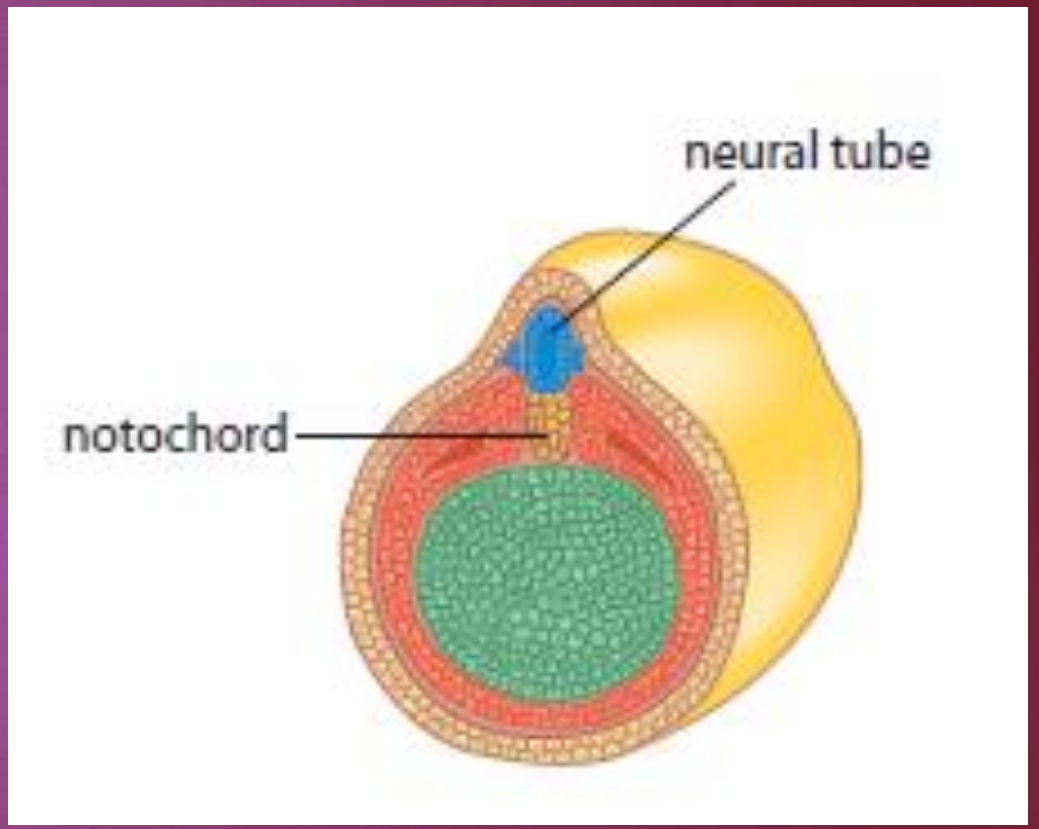



**Figure 13.17** The process of neurulation. **(A)** The notochord forms from mesoderm on the dorsal (back) side of the embryo. **(B)** The neural tube starts as a plate of ectoderm just above the developing notochord. **(C)** The edges of this plate fold inward, meeting to form a hollow tube surrounded by cells. The neural tube pinches off from the ectoderm and develops into the spinal cord and brain. **(D)** Cells migrate from the meeting margins of the neural tube and eventually form other organs, bone, and muscles.

- **neurula** is a vertebrate embryo at the early stage of development in which neurulation occurs.



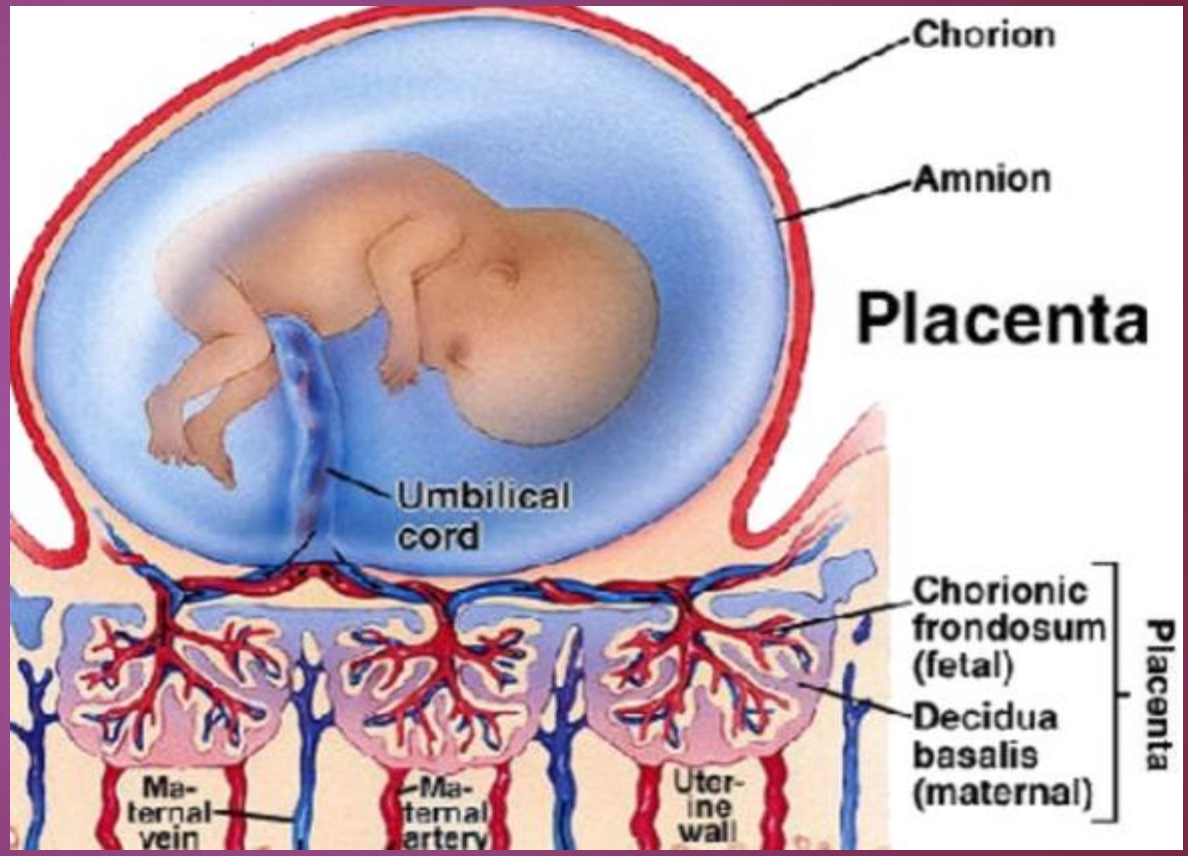



# Extra-Embryonic Membranes

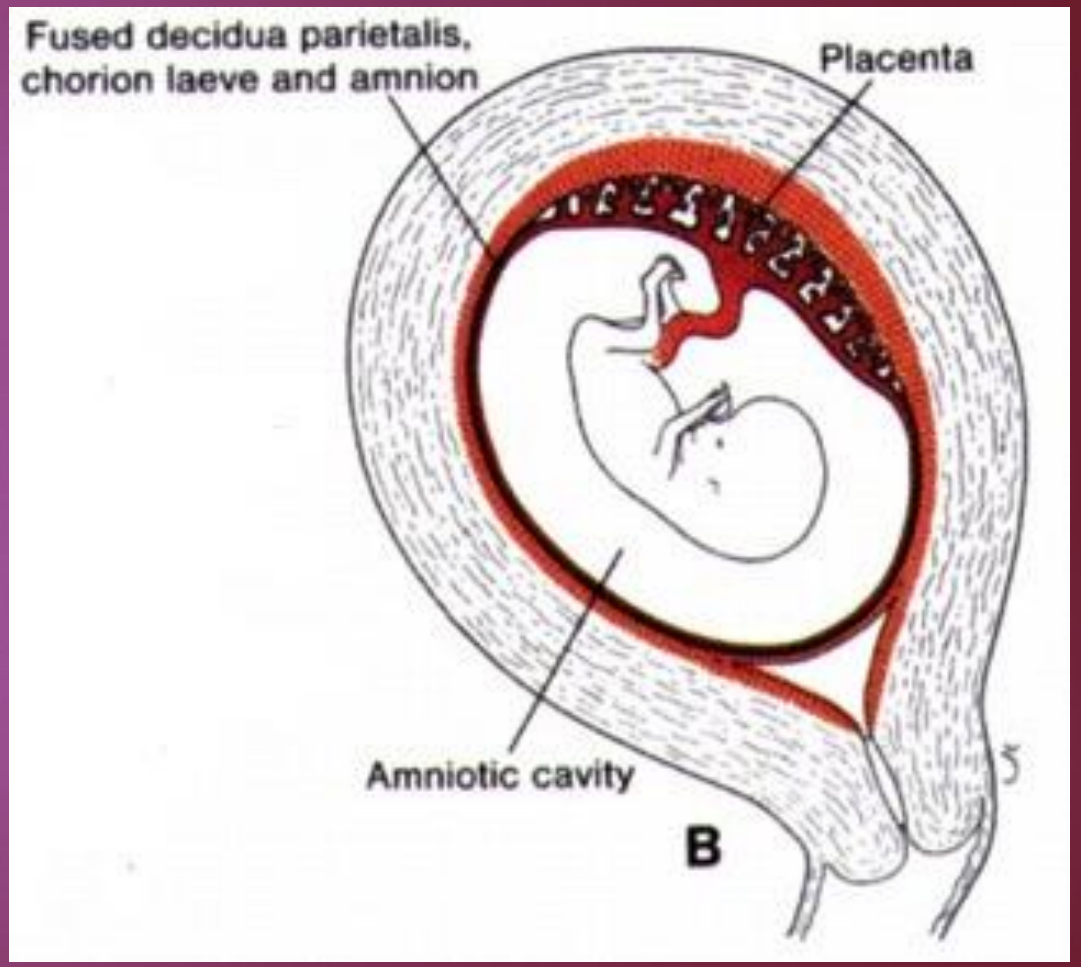
- **extra-embryonic membranes** system of membranes external to the embryo for protection, nutrition, respiration, and excretion

- *Allantois*
- *Amnion*
- *Chorion*
- *yolk sac*

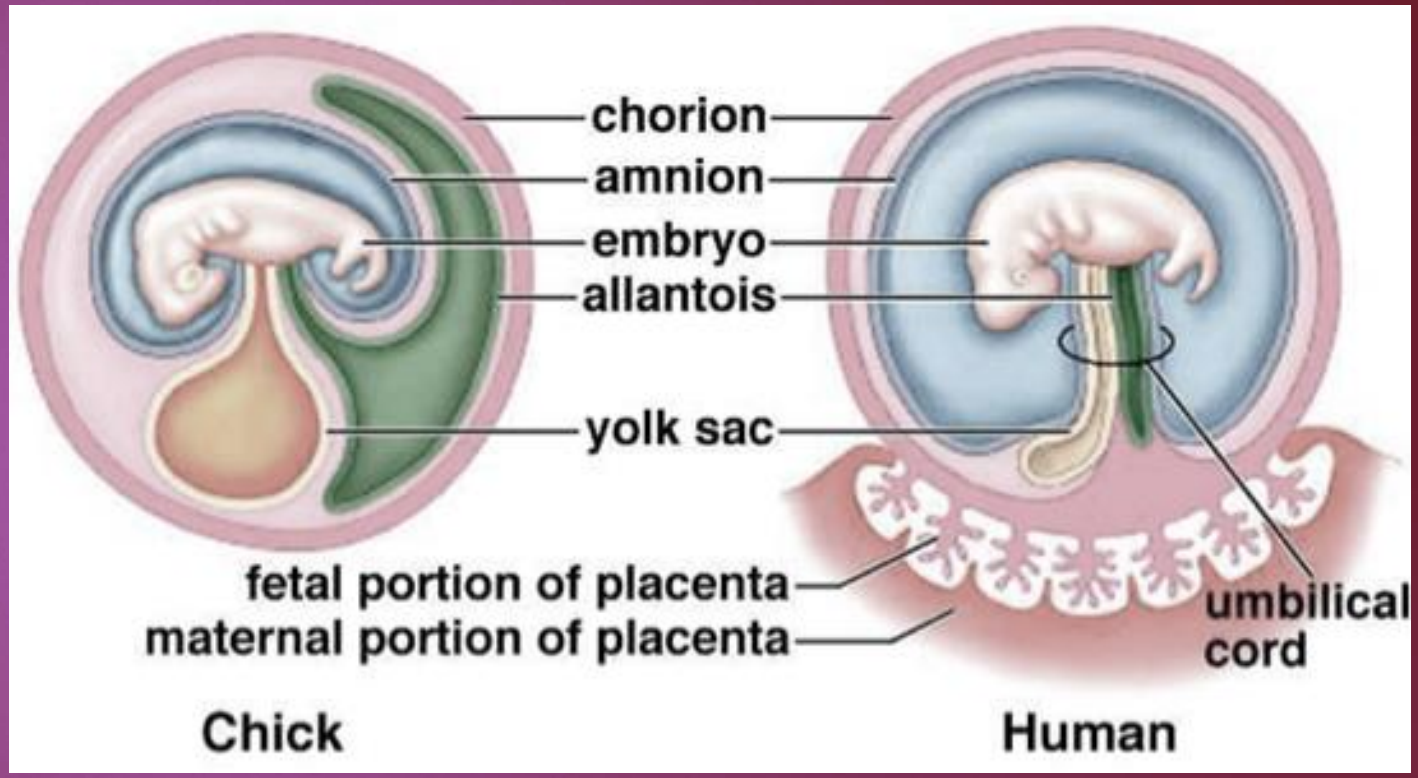
- **Chorion** the outermost membrane. It encloses all the other extra-embryonic membranes, as well as the embryo. The chorion forms the fetal portion of the placenta.



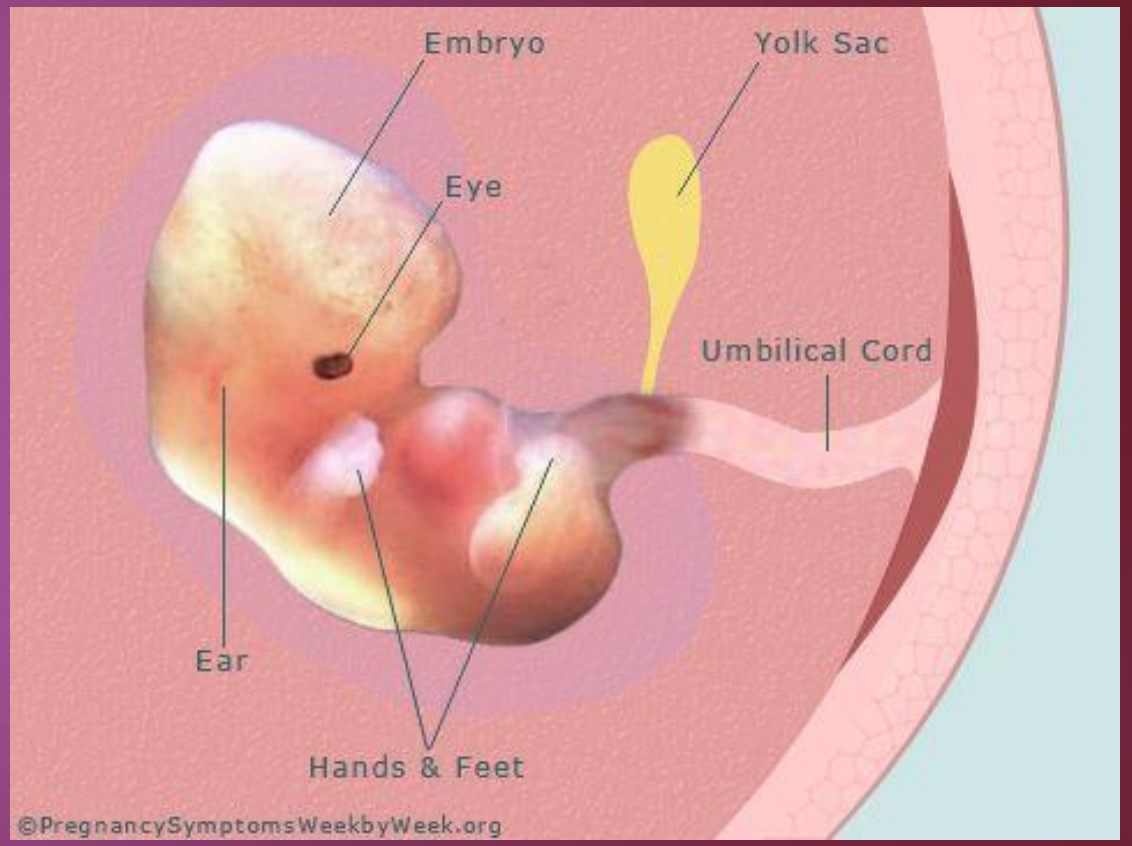
- **Amnion** a transparent sac that develops from cells of the embryonic disk. It grows to enclose the embryo completely.
- It is penetrated only by the umbilical cord.
- The amnion is filled with **amniotic fluid**, which protects the embryo from trauma and temperature fluctuations, allows freedom of movement, and prevents limbs from sticking to the body.



- **Allantois** forms the foundation for the umbilical cord.
- During the second month, most of the allantois degenerates. The remainder becomes part of the urinary bladder.
- It helps the embryo exchange gases and handle liquid waste.

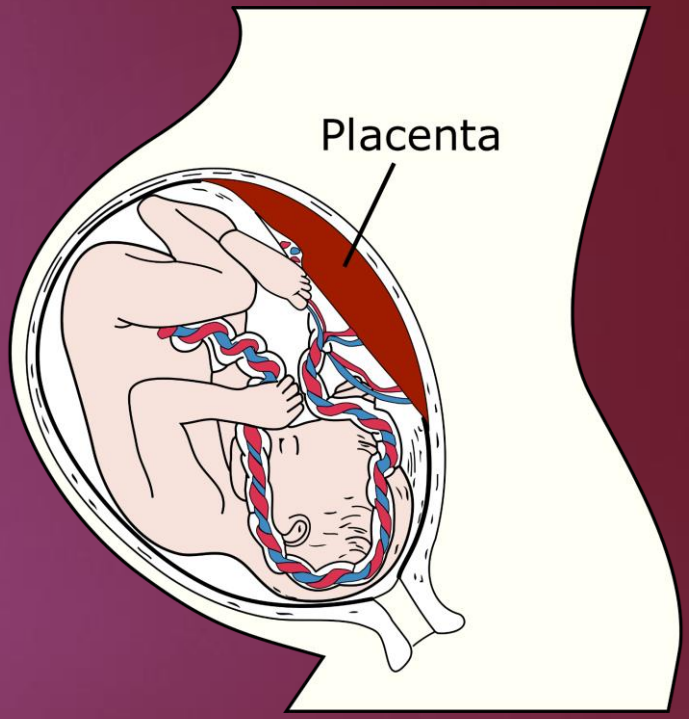


- **Yolk sac** a small sac that is suspended from the abdominal area of the embryo.
- It contributes to the formation of the digestive tract and produces the first blood cells and the future egg or sperm cells.
- Unlike the yolk sac in many other vertebrates, the yolk sac in humans serves no nutritive function.

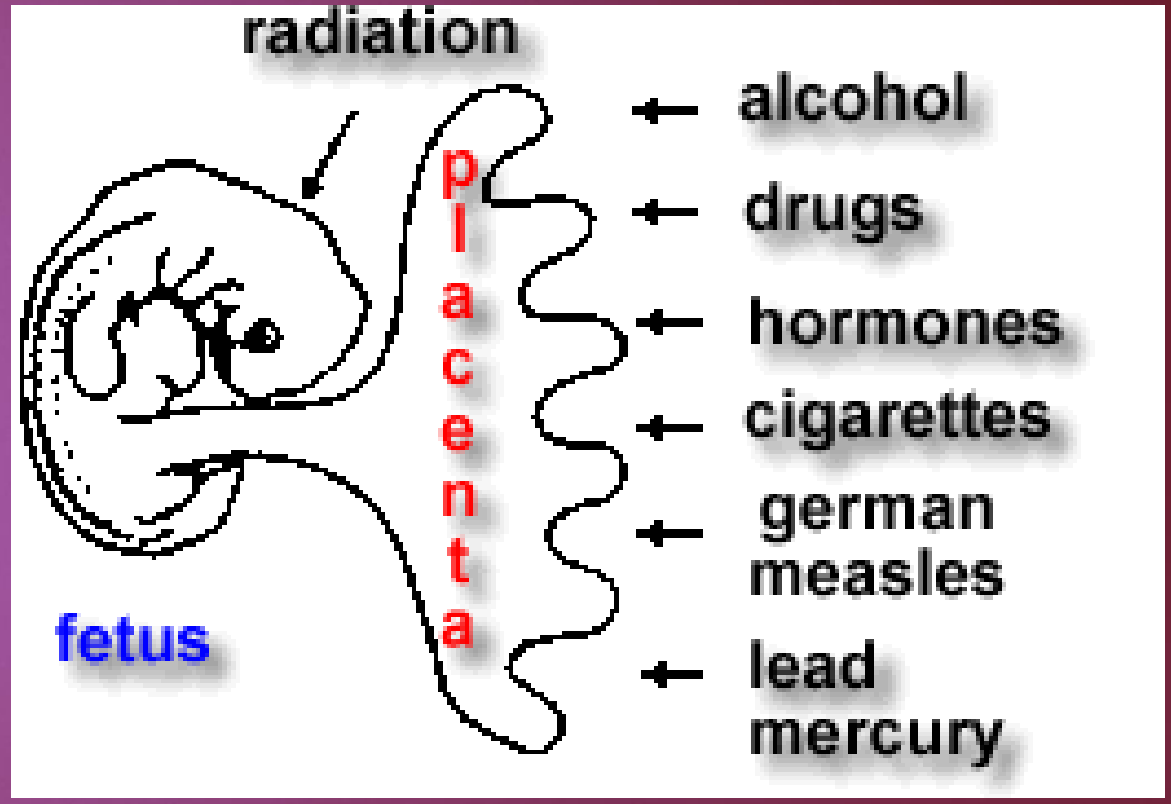


# The Placenta and Umbilical Cord

- **placenta** is a disk-shaped organ that is rich in blood vessels. The embryo (or fetus) is attached to the uterine wall by the placenta, and metabolic exchange occurs through it.
- The placenta is fully developed by about 10 weeks,.
- One part of the placenta—the chorion tissue—comes from the embryo.
- The other part consists of blood pools from the mother's circulatory system.
- The blood systems of the mother and embryo are separate, but they lie very close to each other.
- This proximity permits nutrients and oxygen to diffuse from the mother's circulatory system to the developing baby and for wastes to leave the baby's circulation and enter the mother's for excretion.

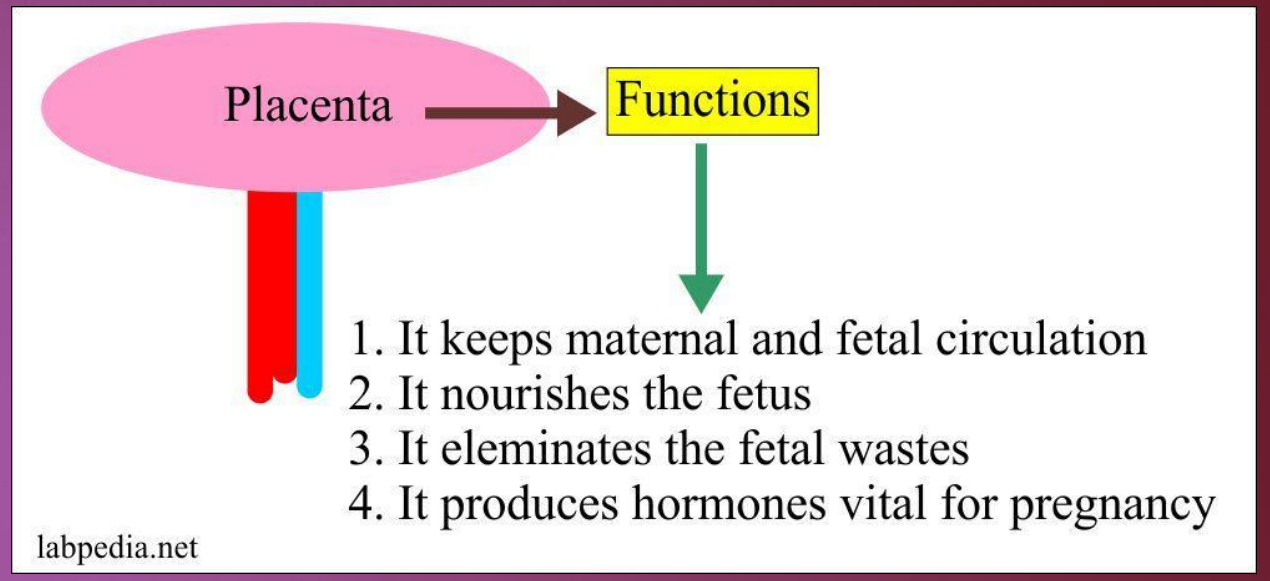


- The placenta does not filter out substances such as alcohol, drugs, and nicotine, which can diffuse across membranes.
- If these substances are present in the mother's blood, they will diffuse into the developing baby's blood.
- Exposure to these substances while pregnant can have severe negative effects on the embryo and fetus.

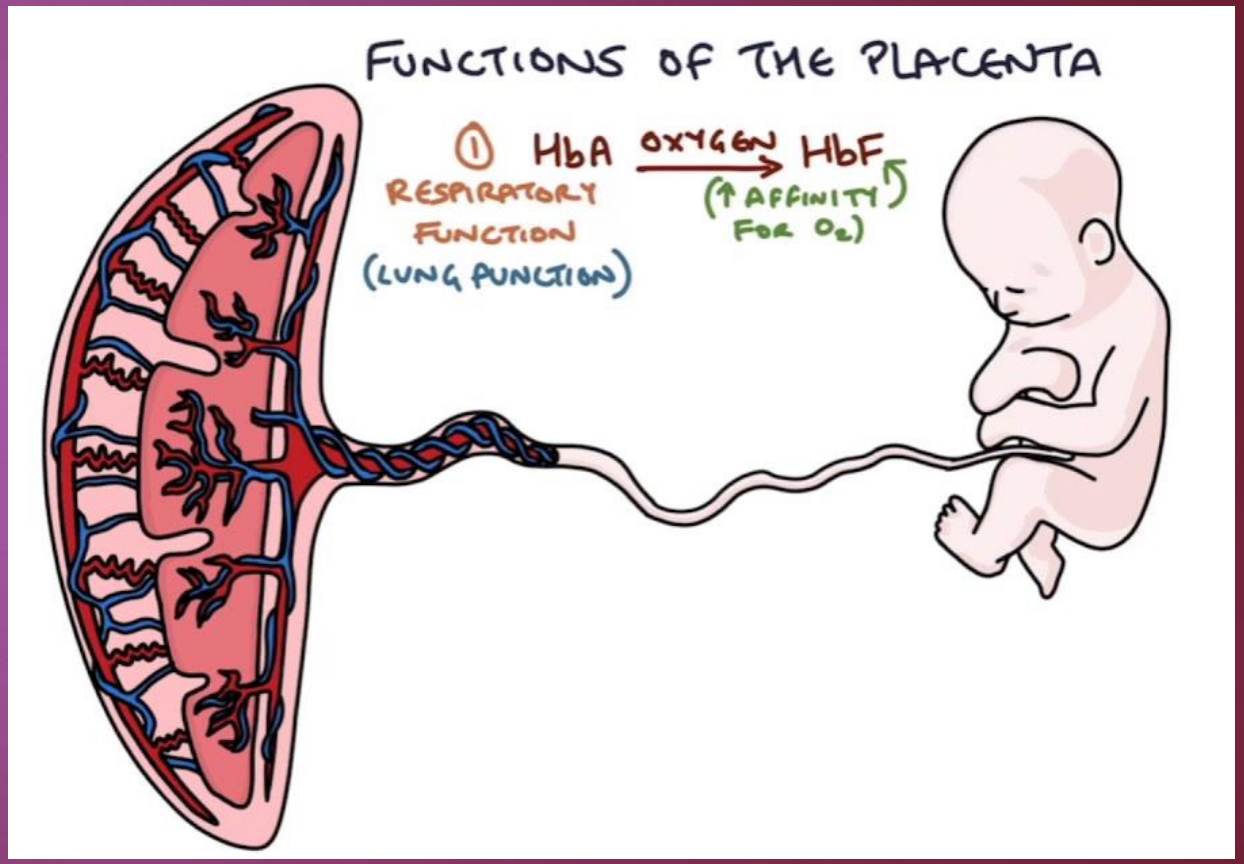


# Functions of the Placenta

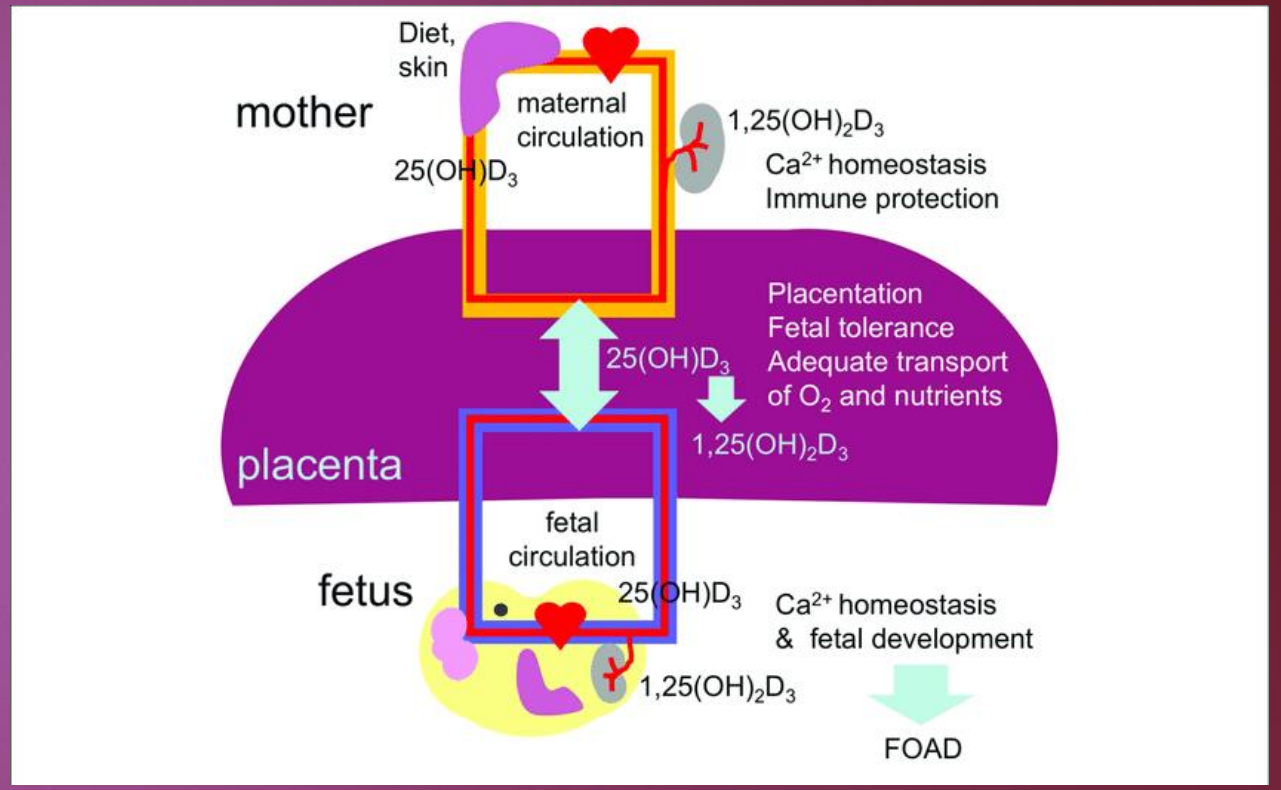
- **Nutritional Functions**
  - Transports nutrients (for example, glucose, amino acids, fatty acids, minerals, and vitamins) from the mother's blood to the fetus's blood
  - Stores nutrients, such as carbohydrates, proteins, iron, and calcium, in early pregnancy and releases them to the fetus later, when fetal demand is greater than the mother can absorb from her diet



- **Excretory Functions**
  - Transports wastes (such as urea, ammonia, and creatinine) from the fetal blood to the mother's bl
- **Respiratory Functions**
  - Transports oxygen from the mother to the fetus and carbon dioxide from the fetus to the mother



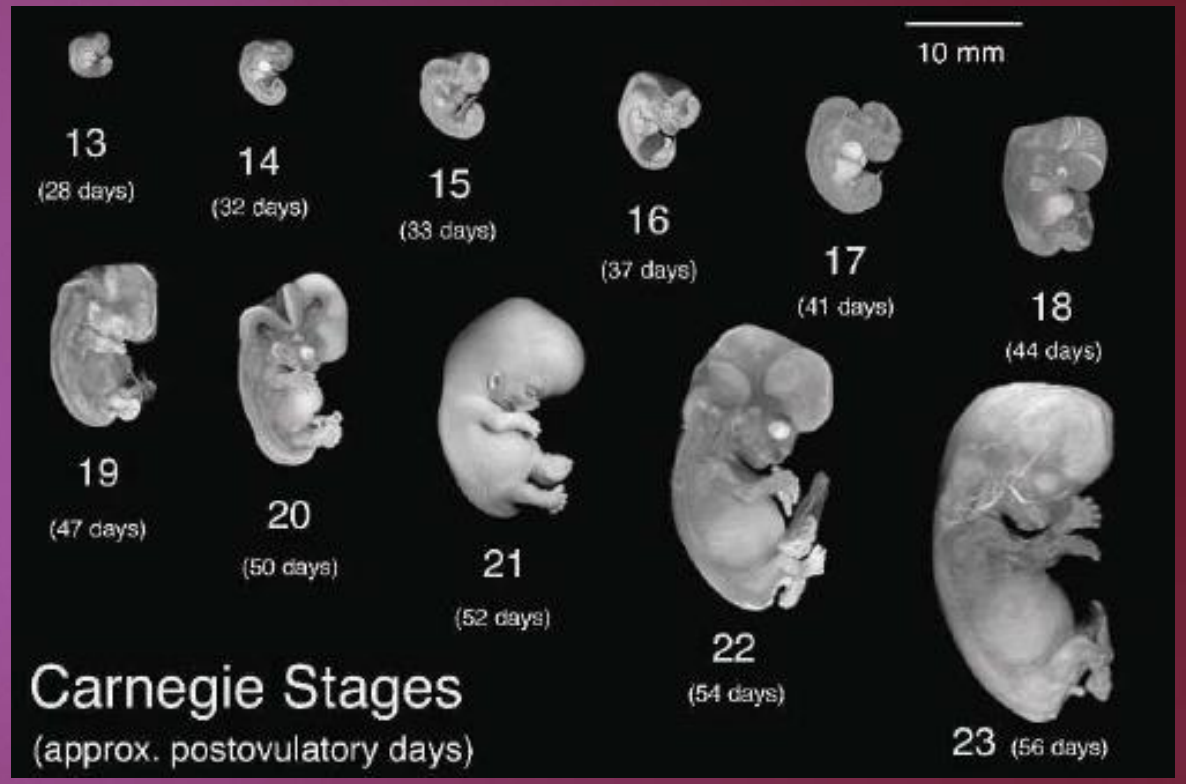
- **Endocrine Functions**
  - Secretes hormones, such as estrogen, progesterone, and human chorionic gonadotropin
  - Allows hormones from the fetus to diffuse into the mother's blood and hormones from the mother to diffuse into the fetus's blood
- **Immune Functions**
  - Transports antibodies from the mother into the fetus's blood to provide passive immunity



- ***umbilical cord*** is a rope-like structure that averages about 60 cm long and 2 cm in diameter. (It can be as long as 300 cm or as short as a few millimetres.)
- It leads from the navel area of the fetus to the centre of the placenta.
- The umbilical cord contains two arteries, which transport oxygen-depleted blood from the fetus to the placenta.
- It also contains one vein, which brings oxygen-rich blood to the fetus. The umbilical cord has natural twists because the umbilical vein is longer than the arteries are.
- In about 20 percent of all deliveries, the umbilical cord is looped once around the baby's neck. Usually, this poses no problem for the baby's health or the delivery. The doctor or midwife can easily slide the umbilical cord over the baby's head before delivery.

# Embryonic Development

- Soon after neurulation begins, a reddish bulge that contains the heart forms. By about the 18th day, the heart starts beating.
- The **fourth week** of prenatal development and on is a time of rapid growth and differentiation.
- Blood cells start to form and fill developing blood vessels. Lungs and kidneys take shape.
- Small buds, which will develop into arms and legs, appear.
- A distinct head is visible, as well as early evidence of eyes, ears, and nose.

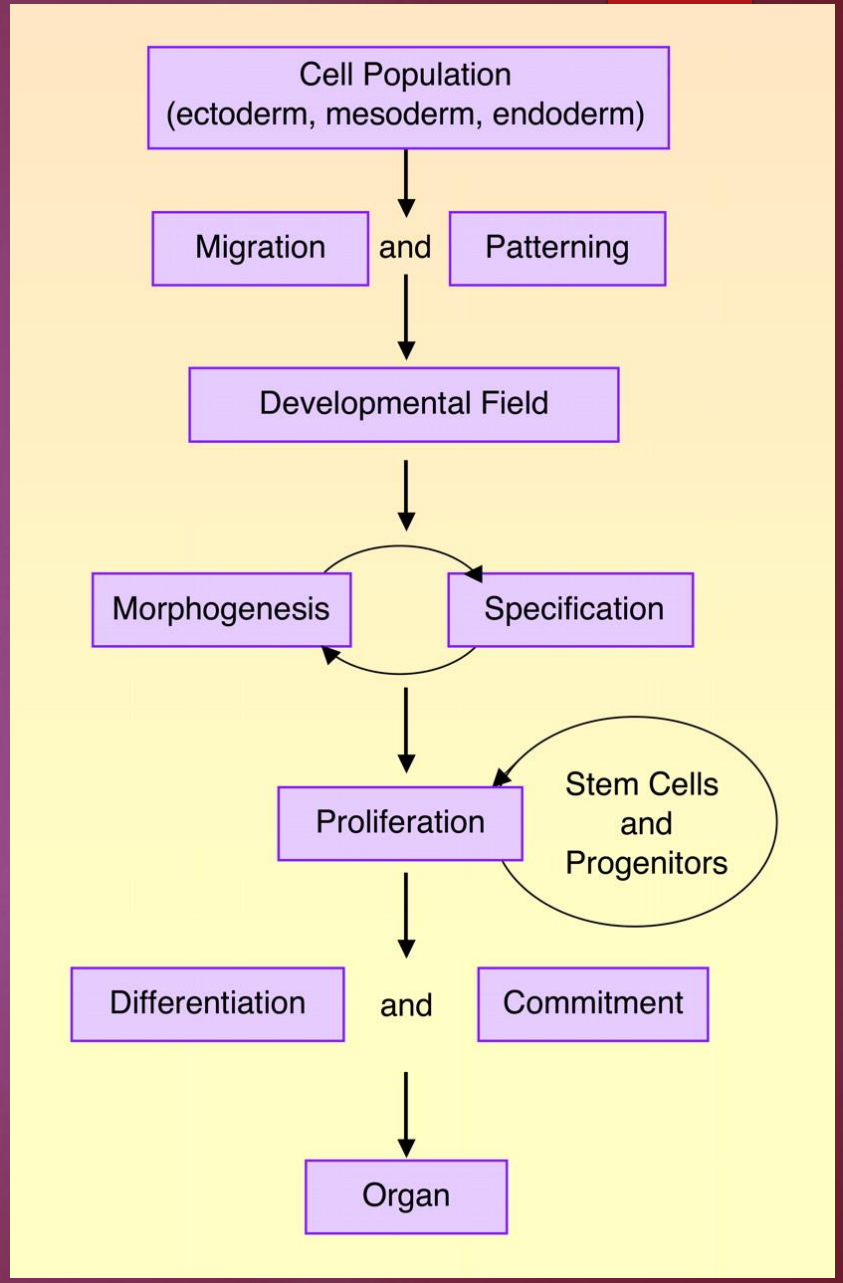


- During the **fifth week**, the embryo's head is very large compared with its body. The eyes open, but they do not yet have eyelids or irises.
- Cells in the brain are differentiating very quickly.
- In the **sixth week**, the brain continues its rapid development. The limbs lengthen and flex slightly. The gonads are starting to produce hormones that will influence the development of the external genitalia.

- **embryo** is the early stage of development of a multicellular organism. Usually 1-8 weeks.

# Organogenesis

- **Organogenesis** is the process by which the three germ tissue layers of the embryo, which are the ectoderm, endoderm, and mesoderm, develop into the internal organs of the organism.
- During the **seventh and eighth** weeks, the embryo has distinct human characteristics. **The organs are formed**, and the nervous system is starting to co-ordinate body activity.
- By the end of the eighth week of prenatal development, Approximately 90 percent of the organs



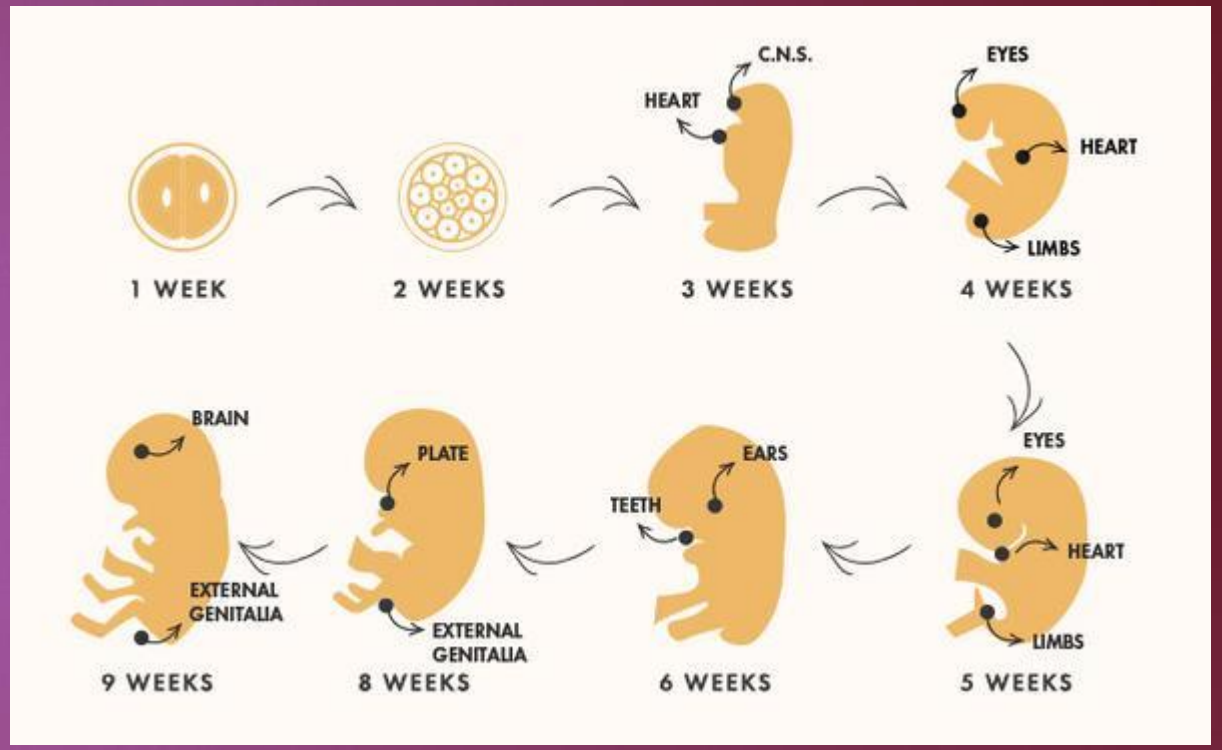
- Engage in Investigation 13.C (*NL Biology*, p. 517) to observe embryonic development and compare human and chick embryos.

# Fetal Development

- The fetal period of development starts during the ninth week and lasts until birth.
- During this period, the fetus looks obviously human. The main difference between the embryonic and the fetal periods relates to the organs.
- In the embryo, most of the organs are taking shape. In the fetus, the organs are present and continue to develop.
- The embryonic period is a time of morphogenesis. The fetal period, on the other hand, is a time of growth and "refinement" of the existing structures.

# First Trimester Developments (Weeks 1 to 12)

- The embryonic period of development takes place in the first eight weeks after fertilization.
- During the next four weeks—the last month of the first trimester—growth in the length of the body accelerates, but growth of the head slows
- The cartilage based skeleton begins to harden, with the development of bone.
- **By the end of the 12th week, the external reproductive organs are distinguishable as male or female.**



# Second Trimester Developments (Weeks 13 to 24)

- **By the fourth month, the heartbeat of the fetus is strong enough to hear with a stethoscope.**
- The bones of the skeleton begin to form.
- The brain grows rapidly, and the nervous system starts to function.
- As the fetal legs grow and develop, the mother begins to feel movement.
- In the **sixth month,** the skin appears wrinkled because there is very little fat beneath it. The skin becomes more pink as blood-filled capillaries extend into it.
- **If the fetus is born at this stage, it is unlikely to survive. It certainly would not survive without medical intervention.**

# Third Trimester Developments (Weeks 25 to 38)

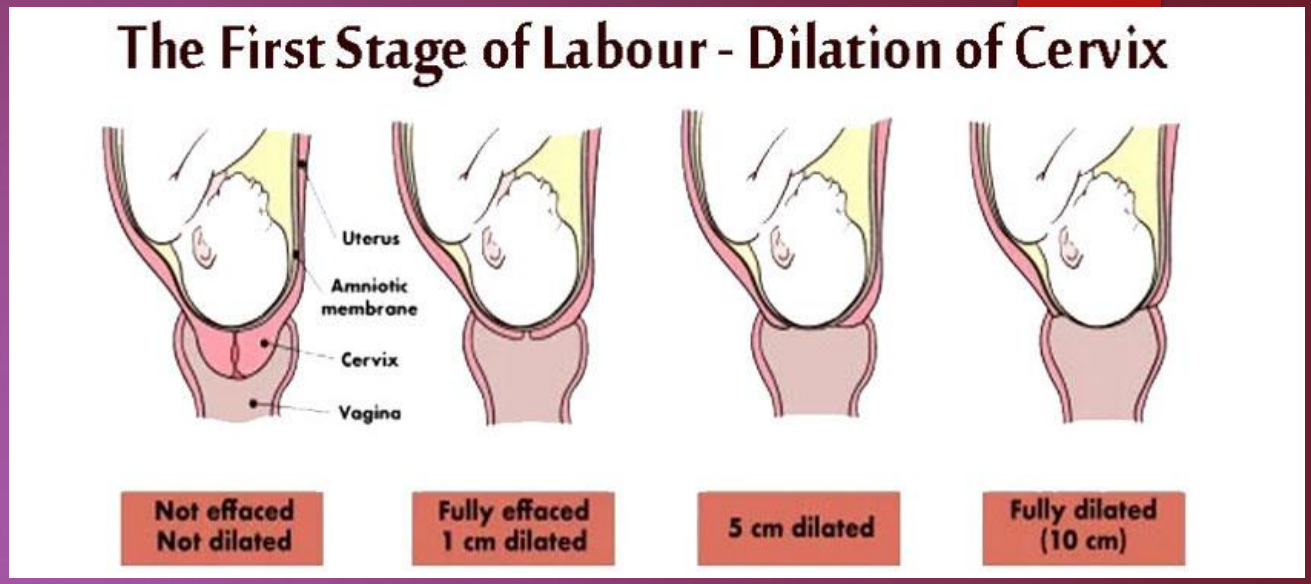
- **Refinement**
- In the third and final trimester, fetal brain cells form rapidly (by the tens of thousands per minute), connecting to form more and more intricate networks.
- The testes of males descend into the scrotum.
- A layer of fat develops beneath the skin.
- The digestive and respiratory systems are usually the last to mature
  - Which is why infants that are born prematurely often have difficulty digesting milk and breathing.
- Proper nutrition is important during all of pregnancy, for both the mother and the fetus. Nutrition is especially important during the third trimester.
- Poor nutrition damages the placenta, which can lead to low birth weight, short stature, delayed sexual development, and learning disabilities.
- About 266 days (approximately 40 weeks) after the formation of a single fertilized cell, a multi-trillion-celled being is ready to be born.

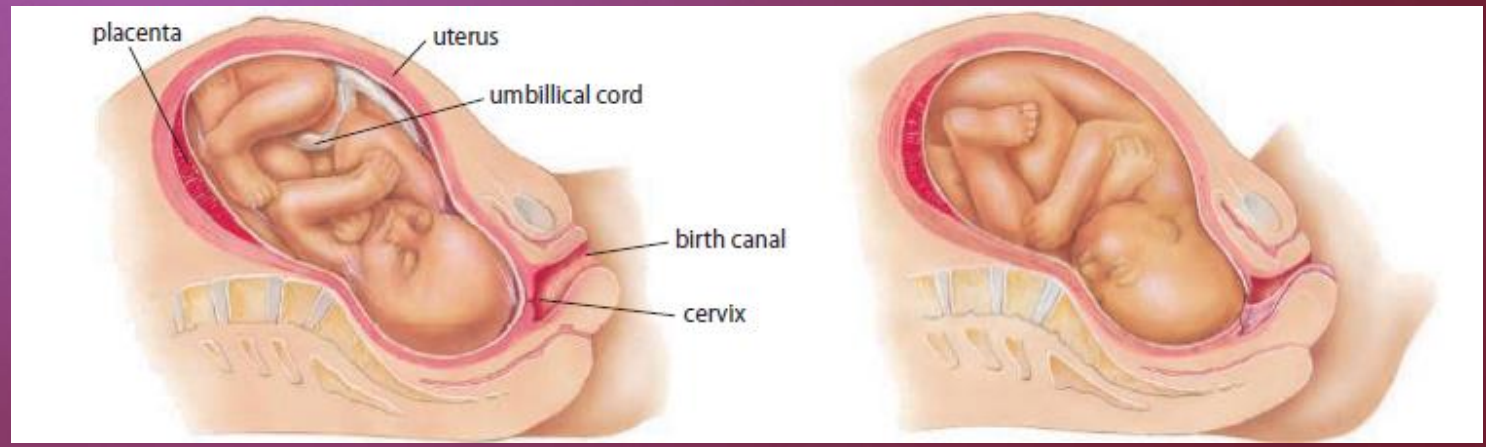
# Parturition: Delivery of the Baby

- **parturition** the process of giving birth
- All the events associated with parturition are commonly referred to as *labour*.
- The uterus experiences contractions throughout pregnancy.
- At first, these are light, lasting about 20 to 30 seconds and occurring every 15 to 20 minutes. Near the end of pregnancy, the contractions become stronger and more frequent.
- The onset of labour is marked by uterine contractions that occur every 15 to 20 minutes and last for 40 seconds or longer.

# Three stages of parturition (birth)

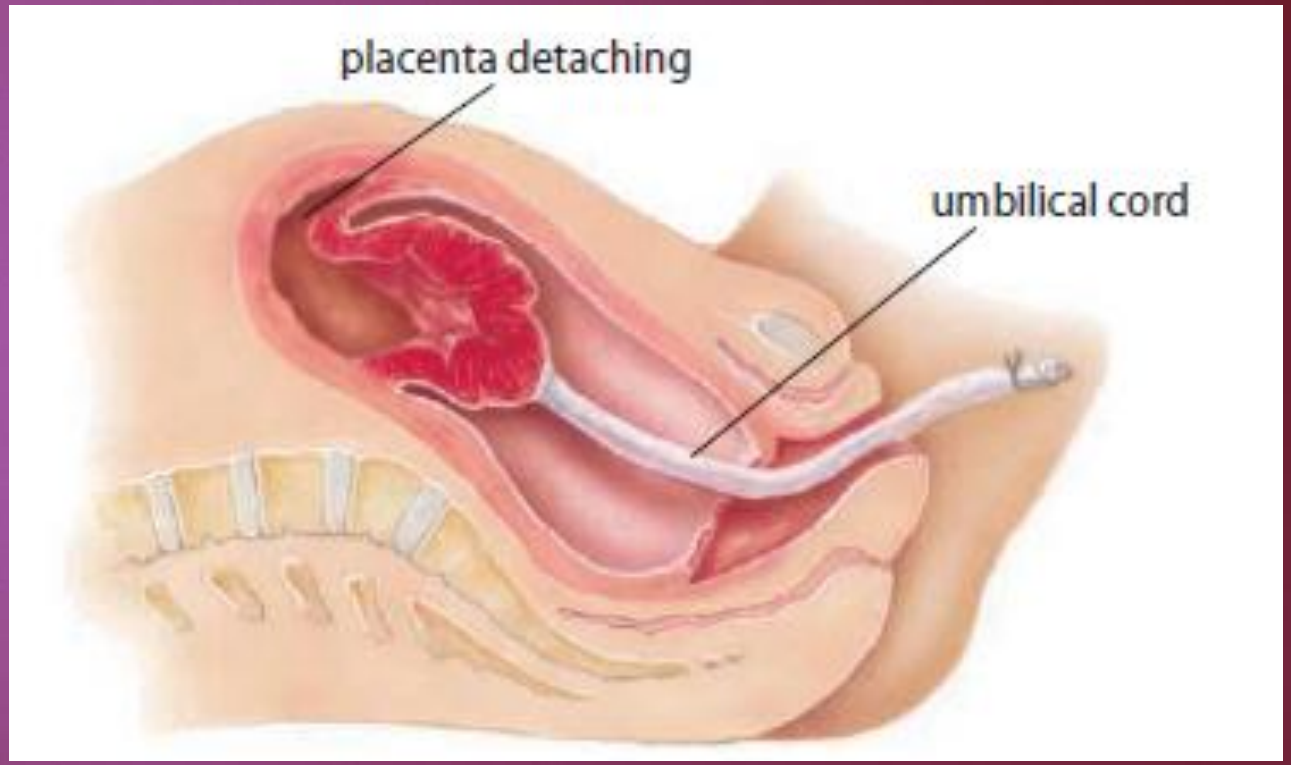
- **Dilation stage** uterine contractions and oxytocin cause the cervix to open, or dilate.
- During this stage, the amniotic sac breaks and the amniotic fluid is released through the vagina. (water breaking)
- The dilation stage usually lasts from 2 to 20 hours.



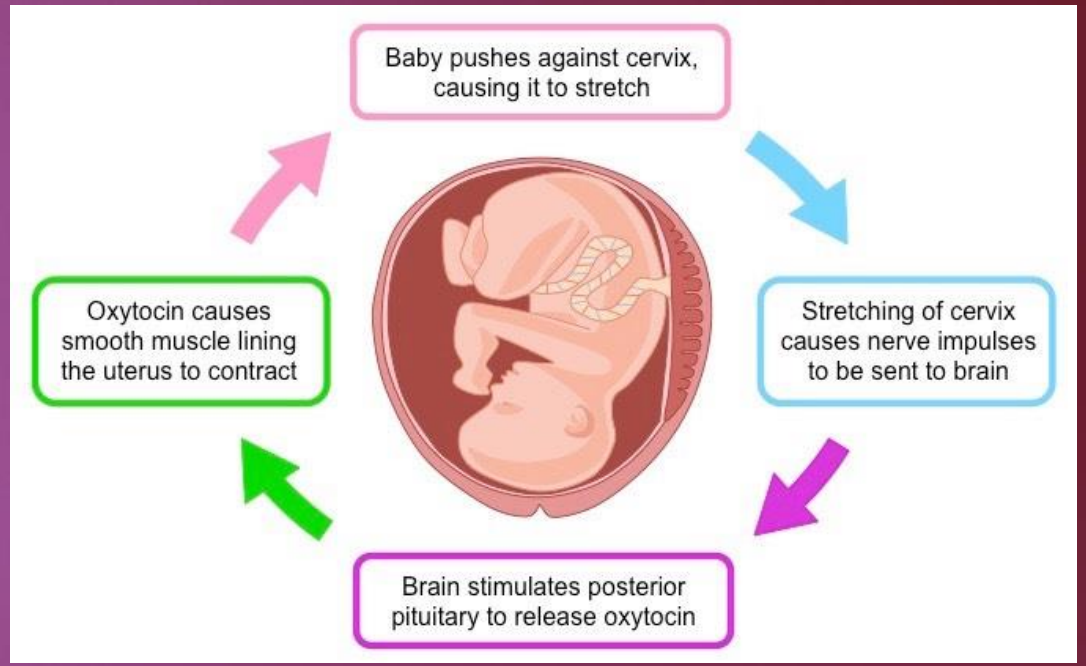
- **Expulsion stage** forceful contractions push the baby through the cervix to the birth canal.
- As the baby moves through the canal, the head rotates, making it easier for the body to pass through the birth canal.
- This stage usually lasts from 0.5 to 2 hours.

- **Placental stage** About 10 to 15 minutes after the baby is born, the placenta and umbilical cord are expelled from the uterus.
- The expelled placenta is called the afterbirth.

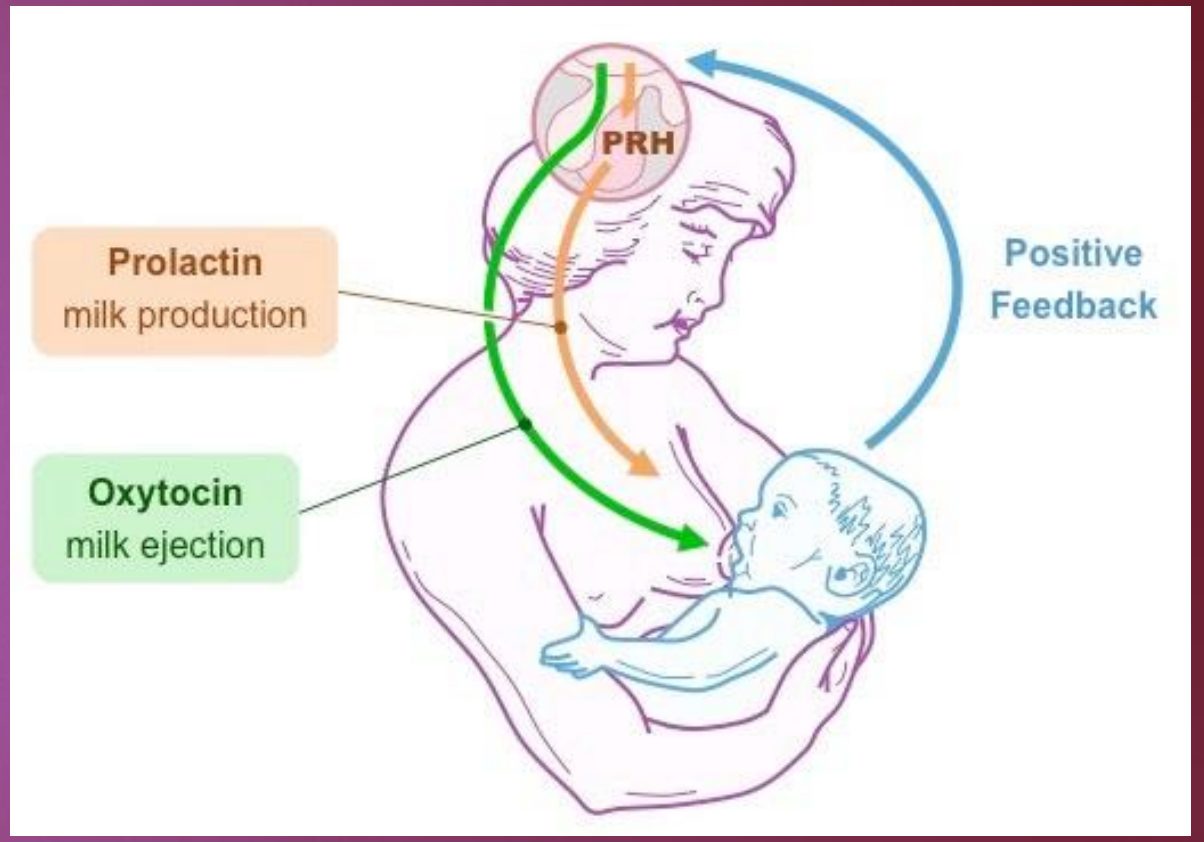


# Positive Feedback Mechanisms

- A **positive feedback** mechanism can explain the onset and continuation of labour.
- Uterine contractions are induced by a stretching of the cervix, which also brings about the release of oxytocin from the posterior pituitary gland
- Oxytocin stimulates the uterine muscles, both directly and through the action of prostaglandins.
- Uterine contractions push the fetus downward, and the cervix stretches even more.
- This cycle keeps repeating itself until birth occurs



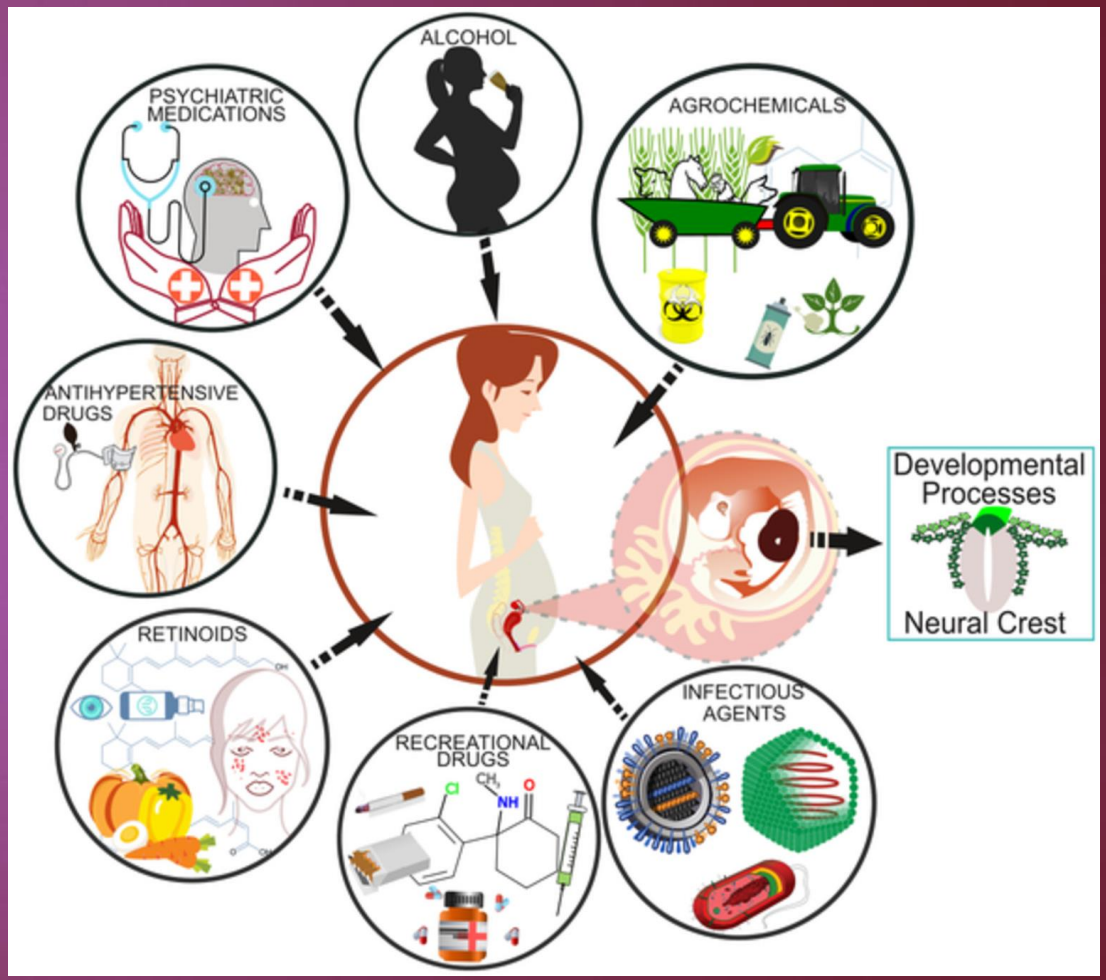
- **lactation** the formation and secretion of breast milk.
- The suckling action of an infant produces prolactin, which leads to milk production
- more suckling leads to more prolactin
- which in turn leads to more lactation.
- This is a positive feedback system as the product (milk) produces more suckling and more hormone.



# The Effects of Teratogens on Development

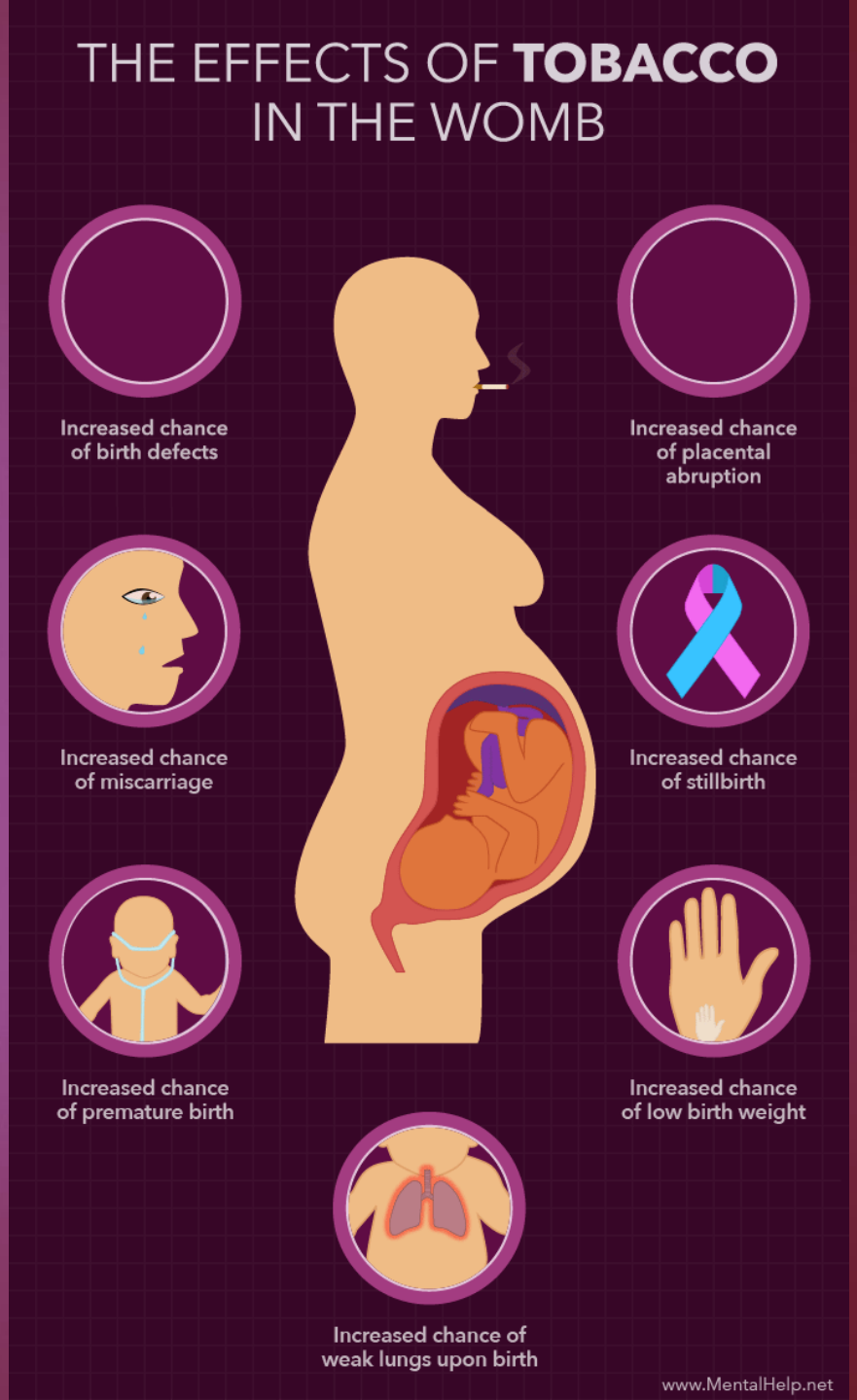
- **teratogen** any agent that causes a structural abnormality due to exposure during pregnancy

- Cigarette smoke
- Alcohol
- Prescription Drugs
- Over the counter Medications
- Infectious Disease
- Radiation
- Chemical Pollutants



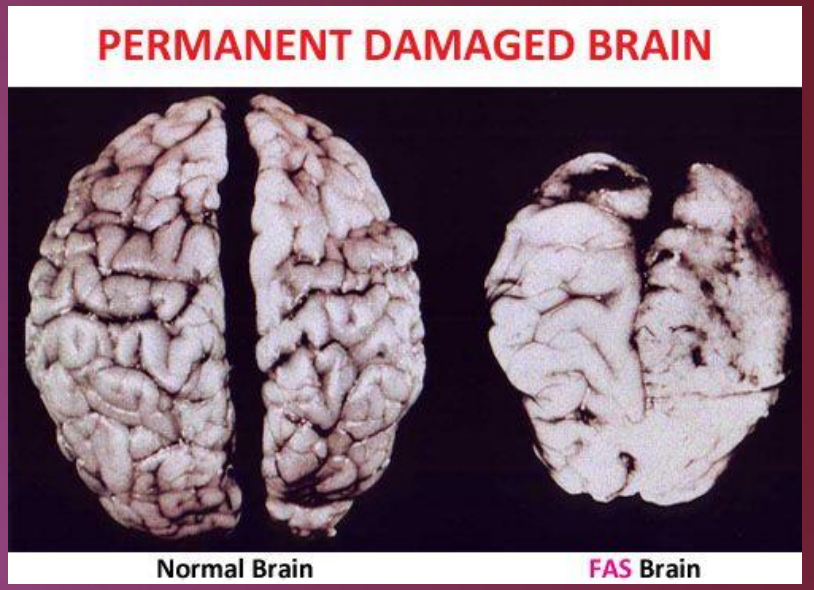
# Cigarette smoke

- can constrict the fetus's blood vessels, preventing the fetus from getting enough oxygen.
- Mothers who smoke or who are exposed to second-hand smoke during pregnancy tend to have babies that are underweight.
- Cigarette smoke during pregnancy also increases the risk of premature births, stillbirths, and miscarriages.
- As well, there is mounting evidence of behavioural problems and reduced intellectual ability in children of smoking mothers.



# Alcohol

- can affect the fetus's brain, central nervous system, and physical development.
- Babies who are affected by alcohol consumption during pregnancy are likely to have decreased weight, height, and head size, as well as malformations of the face and head.
- In addition, these children show varying degrees of learning and memory difficulties and often exhibit unusual aggression or personality disorders.
- The term that is used to describe all the disorders related to alcohol consumption during pregnancy is ***fetal alcohol spectrum disorder*** *(FASD)*.
- his includes the more commonly known clinical disorder called **fetal alcohol syndrome (FAS).**



# Prescription Drugs and Medications

- Many prescription and over-the counter medications have teratogenic properties.
- Examples of medications that are known to have dangerous effects on a fetus include some antibiotics (such as tetracycline), some acne medications, anti-thyroid drugs (for treating hypothyroid and hyperthyroid conditions), and some anti-cancer drugs.
- The most notorious prescription drug with teratogenic effects is **thalidomide**, which was first prescribed in the 1950s to reduce **morning sickness.**
- Its use for pregnant women was discontinued when doctors discovered that an alarming number of babies were being born with missing and deformed limbs.

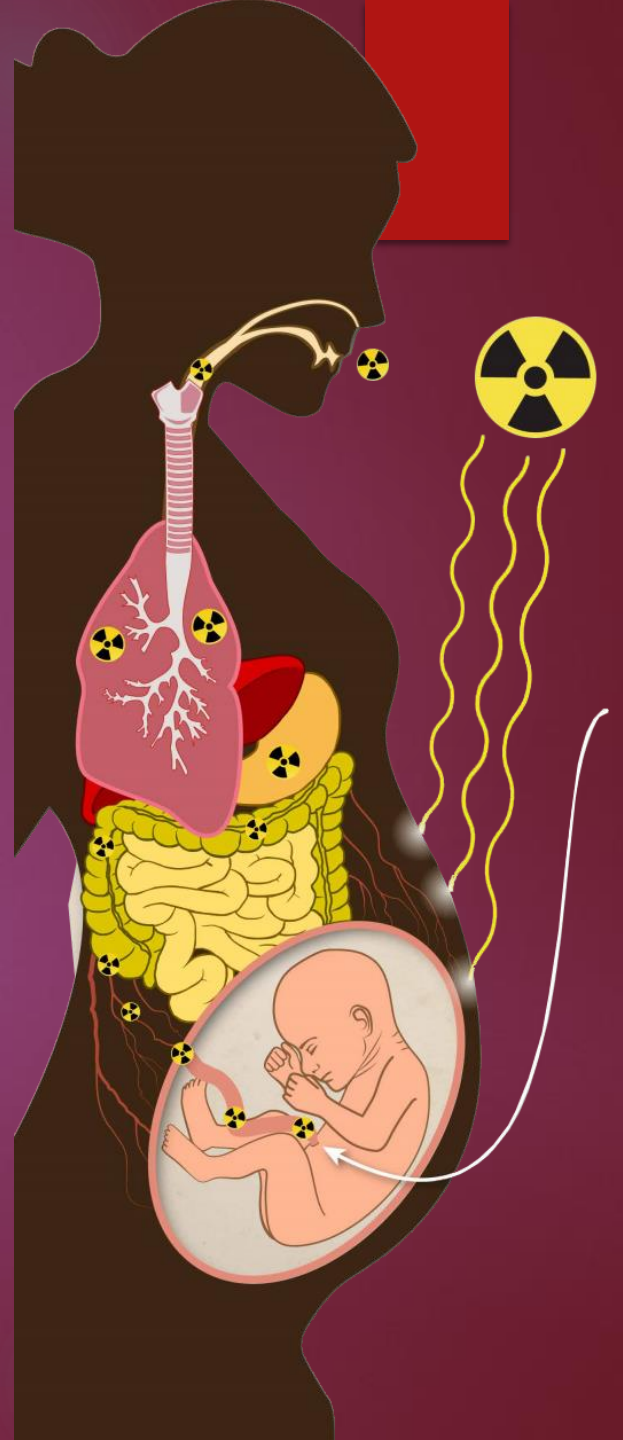
# Infectious Disease

- Maternal infections that can damage the fetus include cytomegalovirus infection, herpes simplex virus infection, rubella, toxoplasmosis, hepatitis B, and syphilis.

- Complications from severe infections during pregnancy may include preterm birth, low birth weight, birth defects, learning problems, and possibly pregnancy loss.

# Radiation

- Most of the ways a pregnant woman may be exposed to radiation, such as from a diagnostic medical exam or an occupational exposure within regulatory limits, are not likely to cause health effects for a fetus.
- However, accidental or intentional exposure above regulatory limits may be cause for concern.
- High Dosages
- Probability of miscarriage may increase
- Probability of major malformations, such as neurological and motor deficiencies, increases.
- Growth restriction is likely



# Chemical Pollutants

- There is also ongoing research about the effects of exposure to elevated levels of pollutants in fish and wildlife for pregnant and nursing women. These environmental contaminants include mercury, lead, cadmium, DDT, and PCBs.

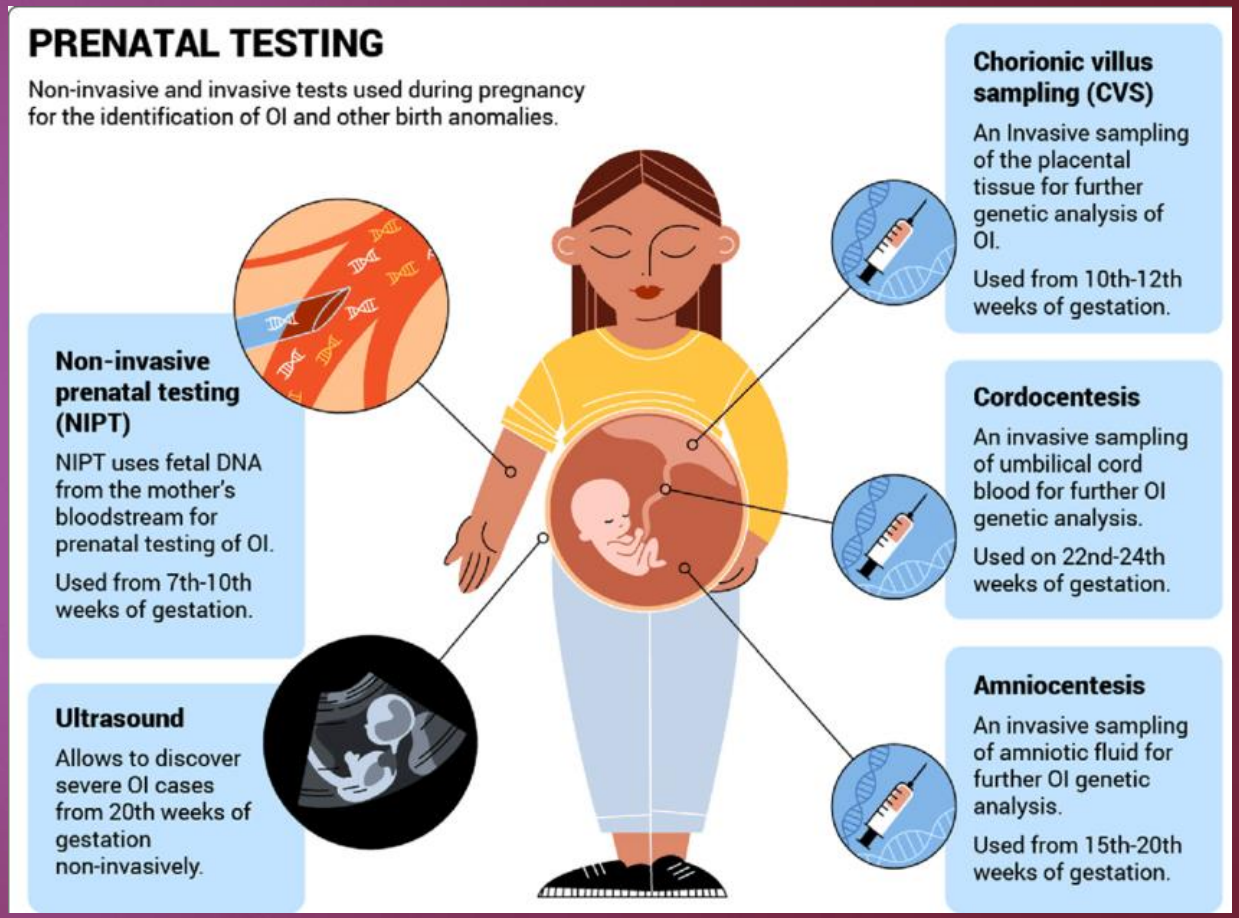
- Pregnant women exposed to DDT are more likely to have premature or small-for-gestational-age babies. DDT is considered a hormone disrupting chemical due to its estrogen-like properties.

# CONNECTIONS + SOCIAL AND ENVIRONMENTAL CONTEXTS

Teratogen Exposure

# Prenatal Screening Techniques

- Home Pregnancy Tests
- Ultrasound
- Fetoscopy
- Amniocentesis
- Chorionic Villi Sampling
- Maternal Blood Tests
- Cell-free DNA Prenatal Screening



# Home Pregnancy Tests

- By the end of the second week of prenatal development, the woman has not yet missed her menstrual period and likely does not know that she is pregnant.
- Her urine does, however, contain enough hCG for an at-home pregnancy test to detect.
- Highly sensitive blood tests can detect hCG as early as three days after fertilization.

# Ultrasound

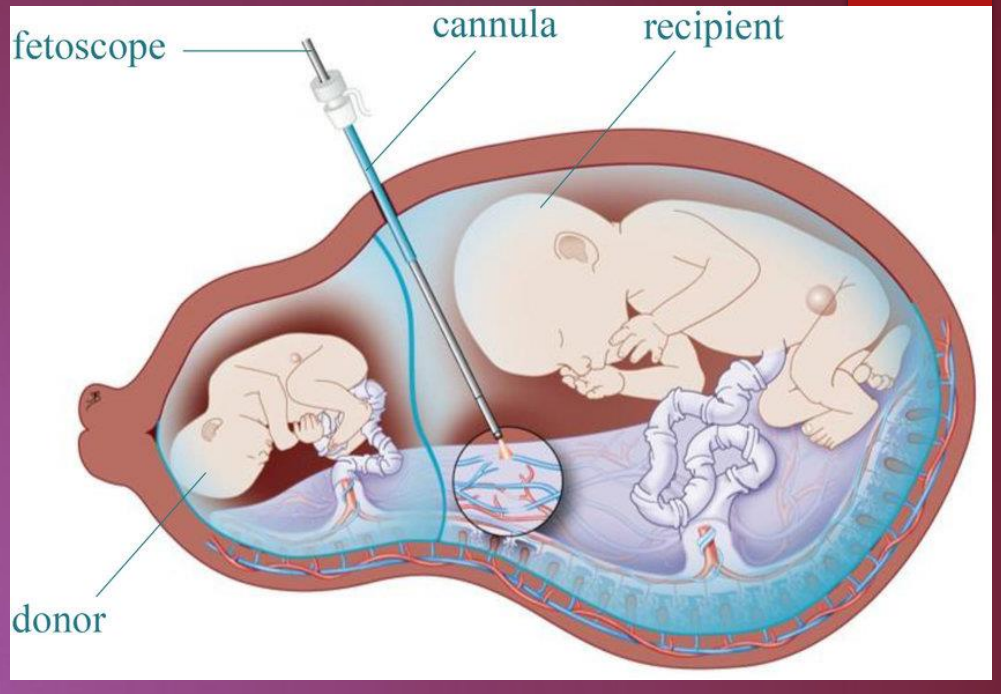
- **ultrasound** sound waves sent through the body provide information about internal structures, such as a developing fetus

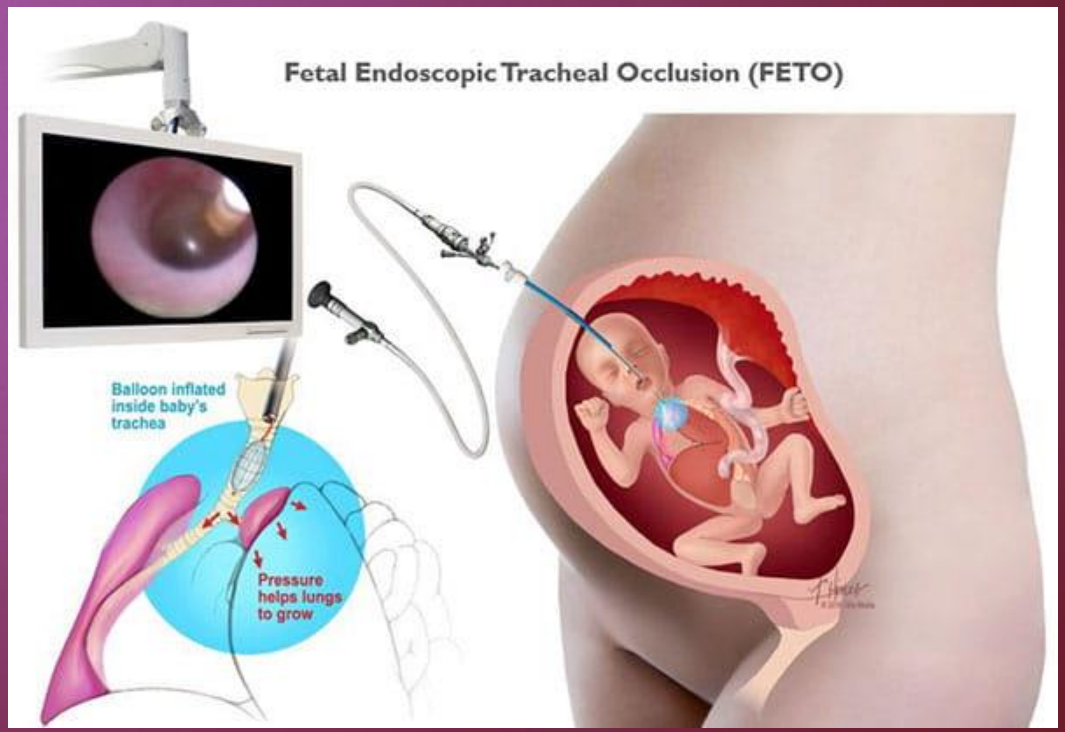
- Does not give DNA information, only physical information

# Fetoscopy

- **Fetoscopy** is an endoscopic procedure during pregnancy to allow surgical access to the fetus, the amniotic cavity, the umbilical cord, and the fetal side of the placenta.

- A small (3–4 mm) incision is made in the abdomen, and an endoscope is inserted through the abdominal wall and uterus into the amniotic cavity.



# Amniocentesis

- **amniocentesis** withdrawal of a sample of amniotic fluid from the uterus after the 14th week of pregnancy for genetic testing. Cannot be preformed before 14 weeks due to risk of injuring the fetus.
- The fluid is placed in a nutrient-rich medium and the cells are allowed to multiply. When the cell sample is large enough, researchers can perform genetic and biochemical tests.

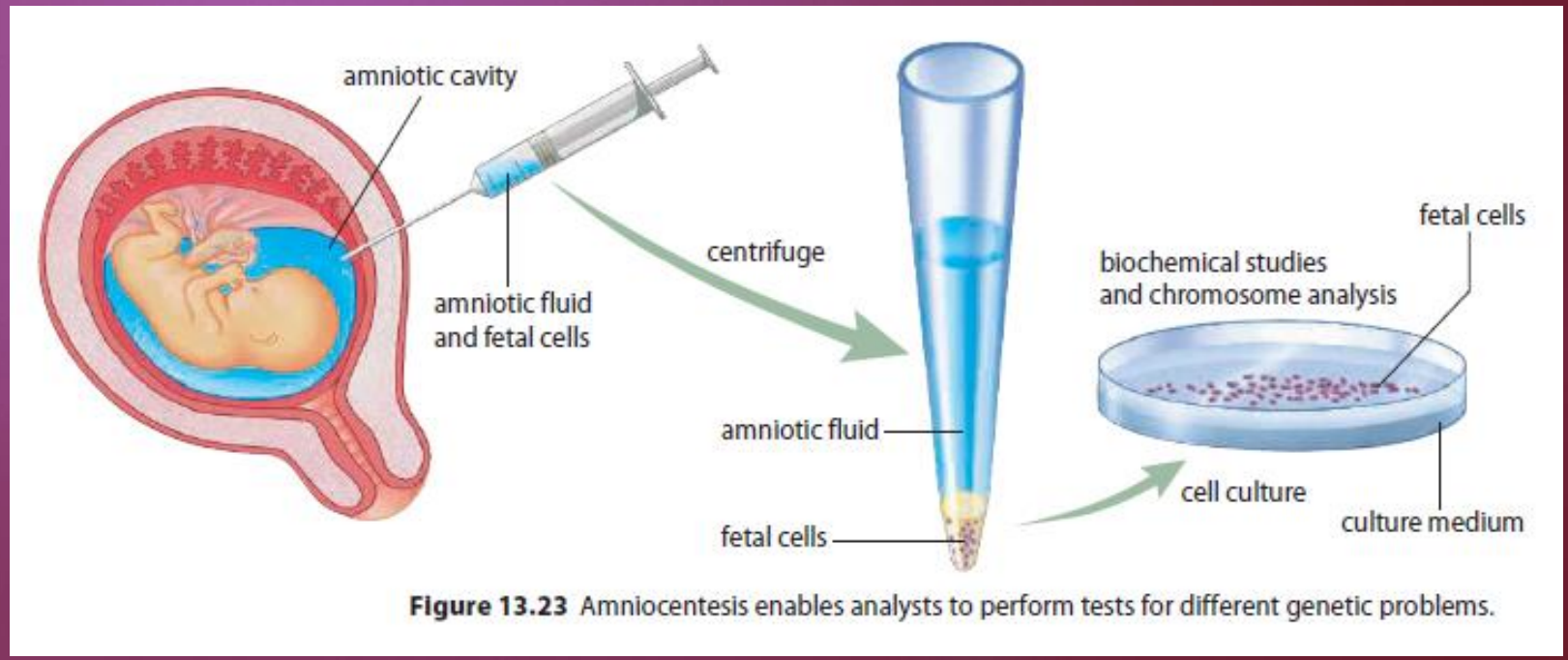



**Figure 13.23** Amniocentesis enables analysts to perform tests for different genetic problems.

# Chorionic Villi Sampling (CVS)

- **chorionic villi sampling** removal of fetal cells from the chorion for genetic testing
- Around the ninth week of pregnancy, cells can be removed from the chorion, which is a tissue that surrounds the amniotic sac. It is one of the tissues that make up the placenta. The chorionic cells are fetal cells, so they carry the same genetic information as the developing fetus.

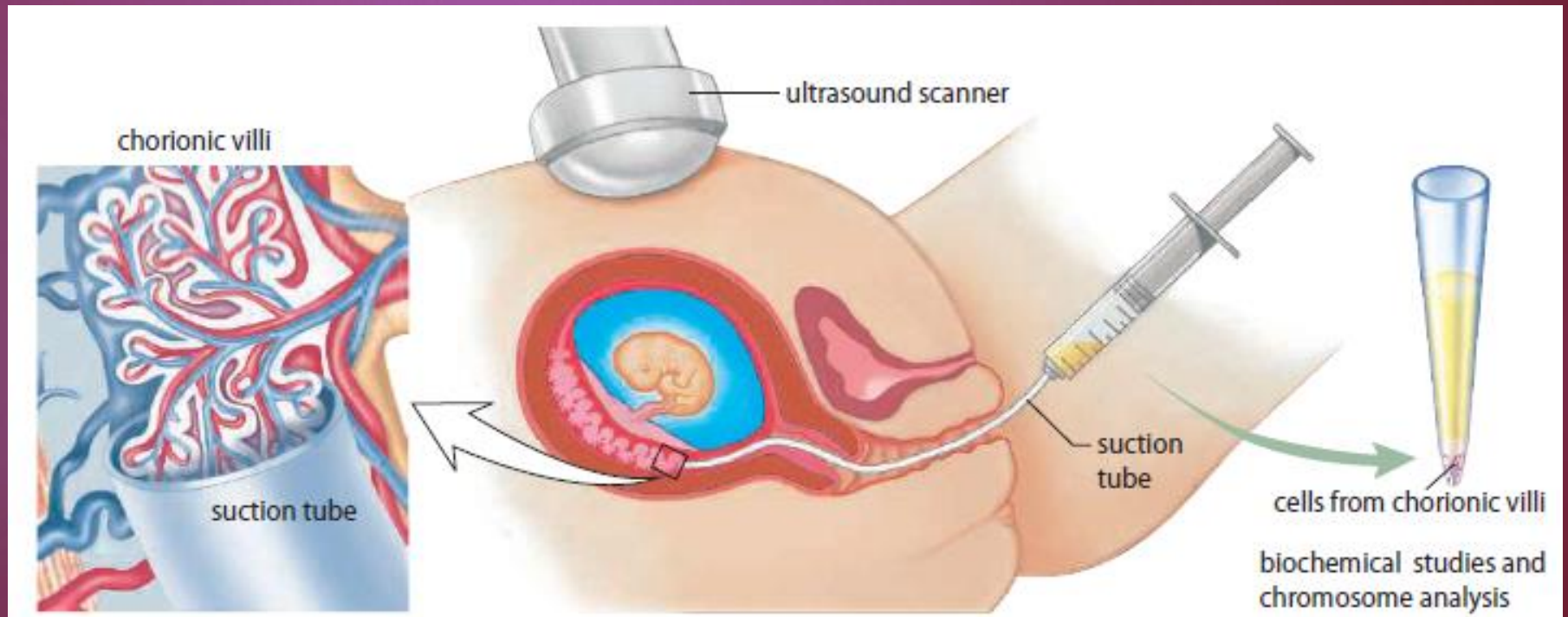
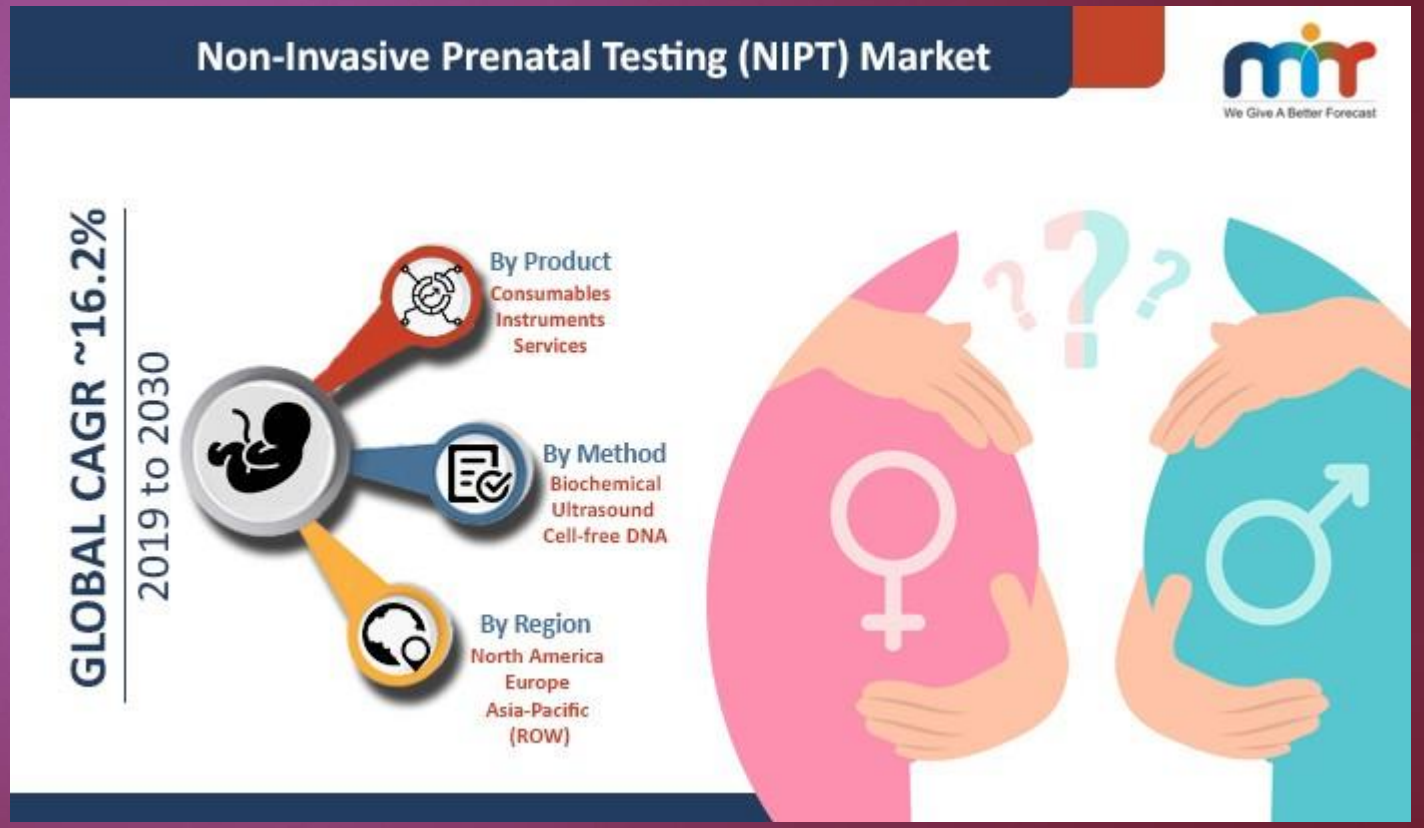


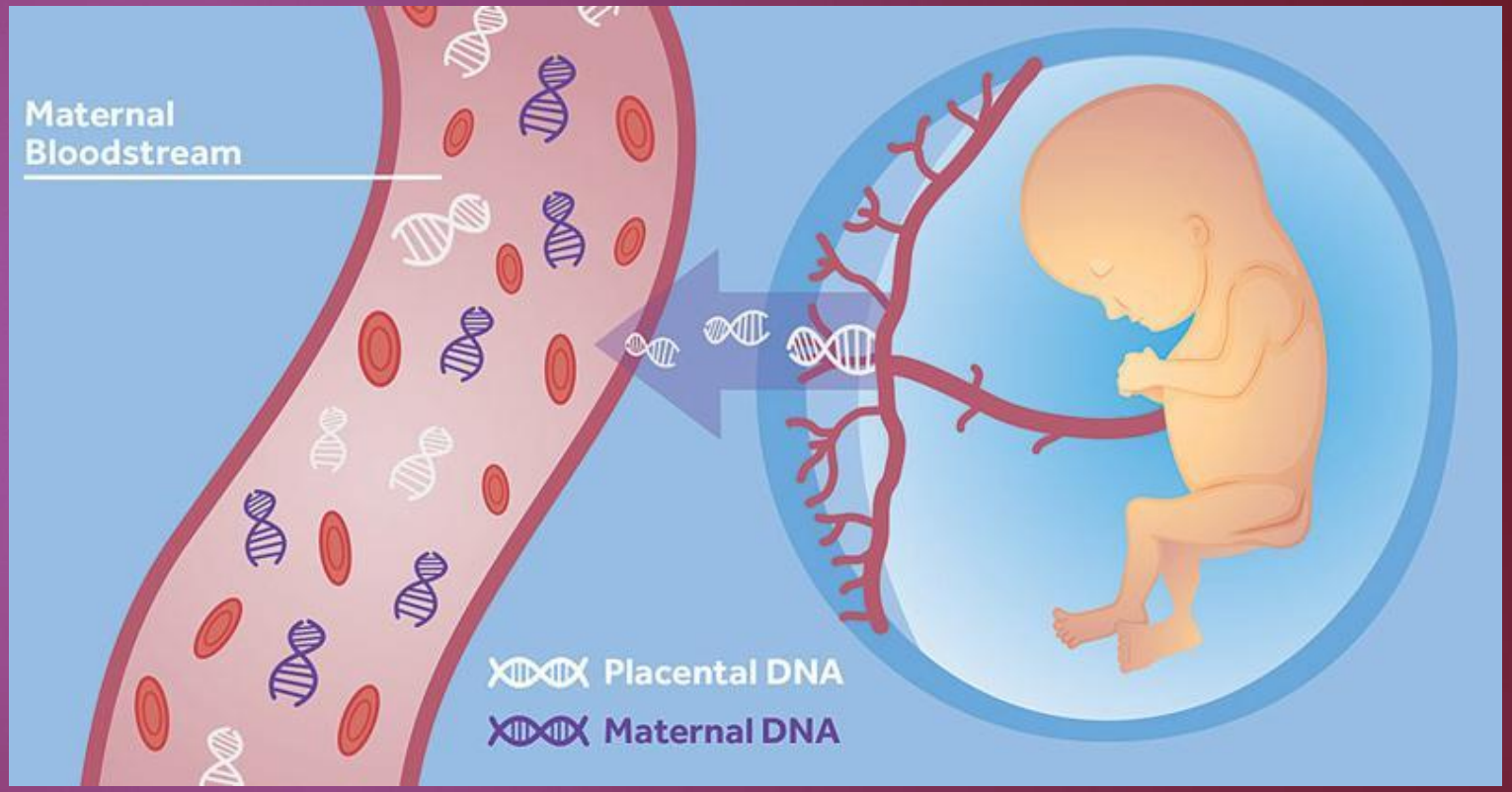

**Figure 13.24** Chorionic villi sampling provides enough cells to perform tests immediately.

# Maternal Blood Tests

- Non-invasive tests, since they do not require direct sampling of fetal cells.
- Can determine factors such as the health and family history of the expectant mother.



- ***Cell-free DNA prenatal screening*** analyzes fragments of cell-free DNA that represents the genetic profile of the fetus, which is derived from the placenta and is in the mother's blood.

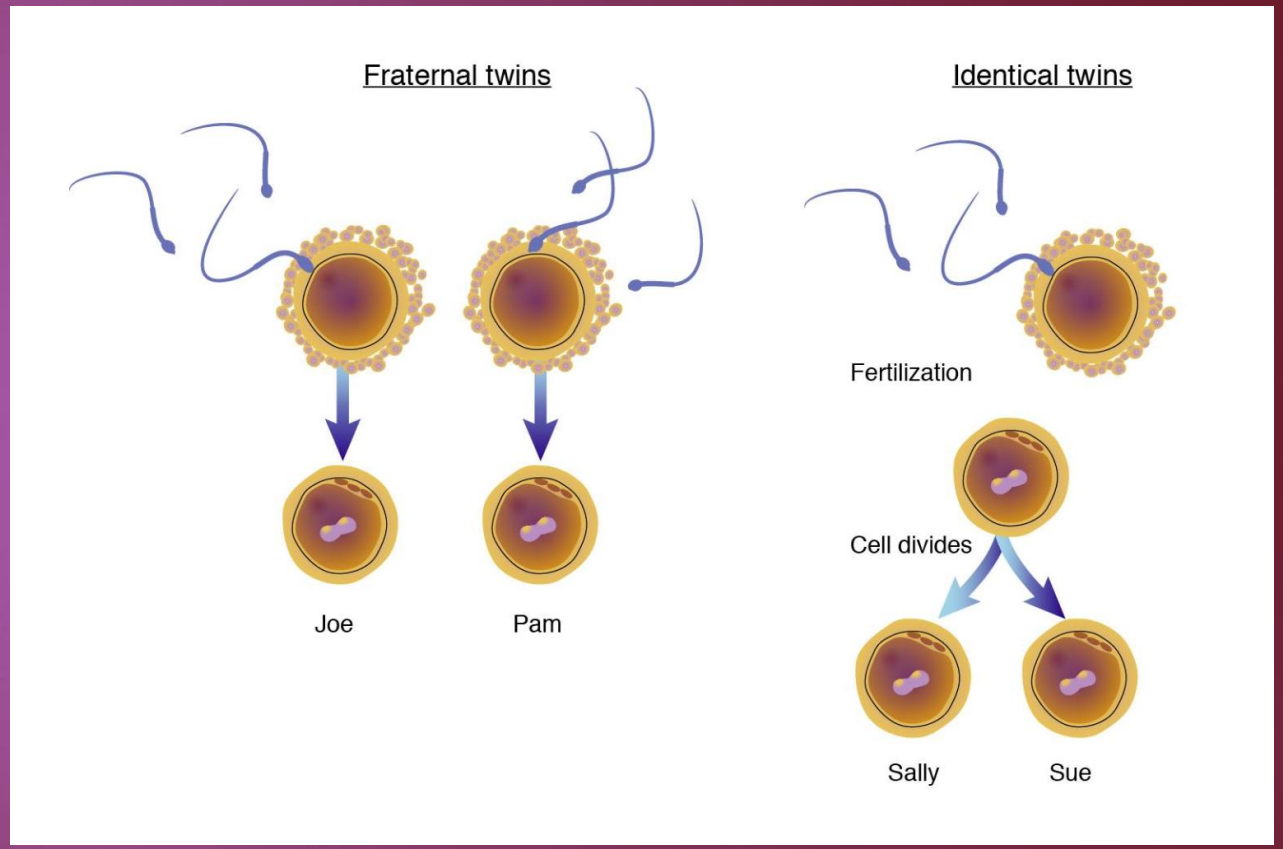


- What issues arise and what decisions have to me made because of prenatal screening?

# Twins

- **Fraternal twins** are also dizygotic twins. They result from the fertilization of two separate eggs during the same pregnancy. Fraternal twins may be of the same or different sexes. They share half of their genes just like any other siblings.

- **Identical twins** are also known as monozygotic twins. They result from the fertilization of a single egg that splits in two. Identical twins share all of their genes and are always of the same sex.



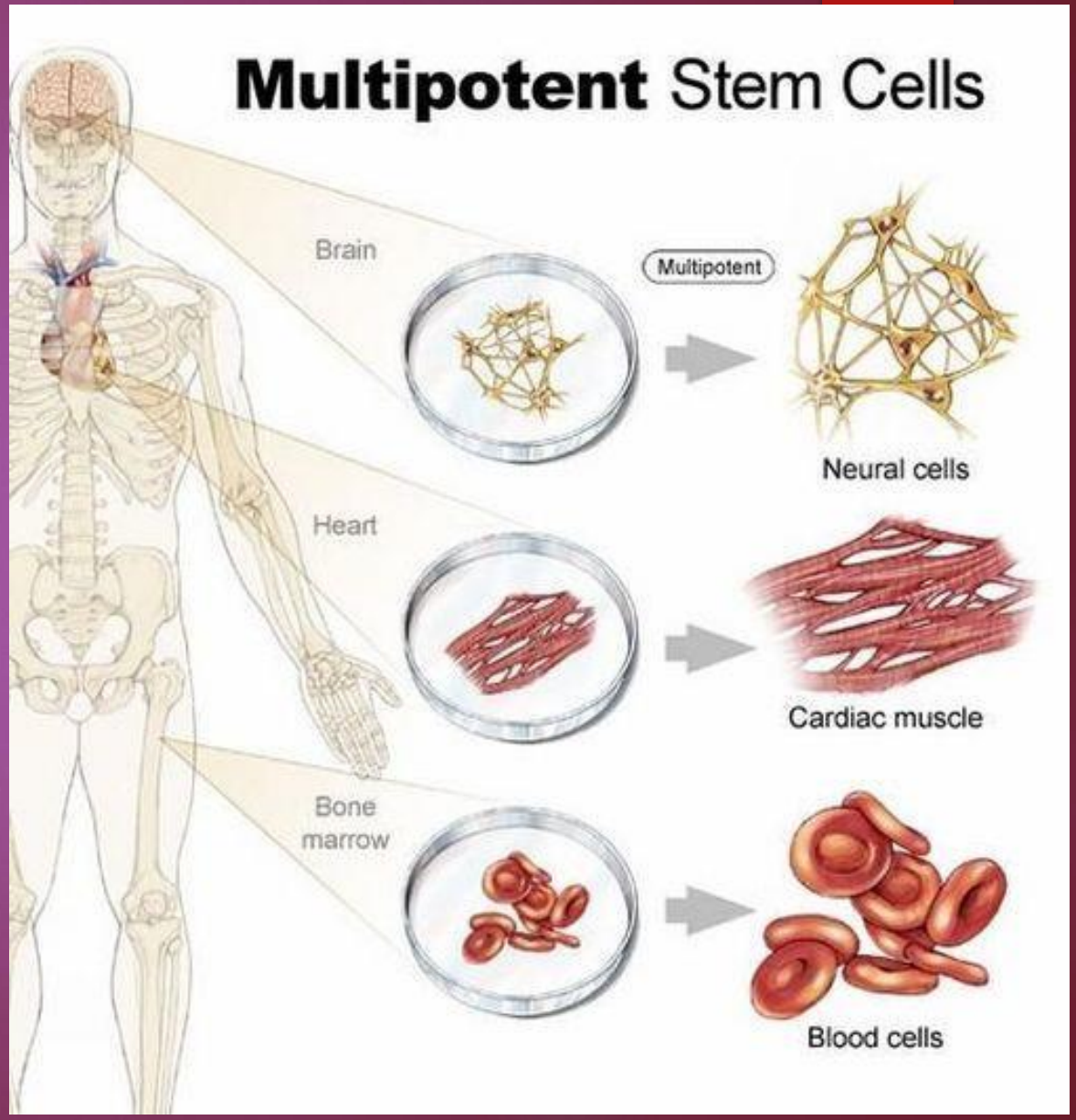
# Stem Cells

- **Stem cells** are special human cells that are able to develop into many different cell types. This can range from muscle cells to brain cells. In some cases, they can also fix damaged tissues.

- Two Types
- Adult Stem Cells
- Embryonic Stem Cells

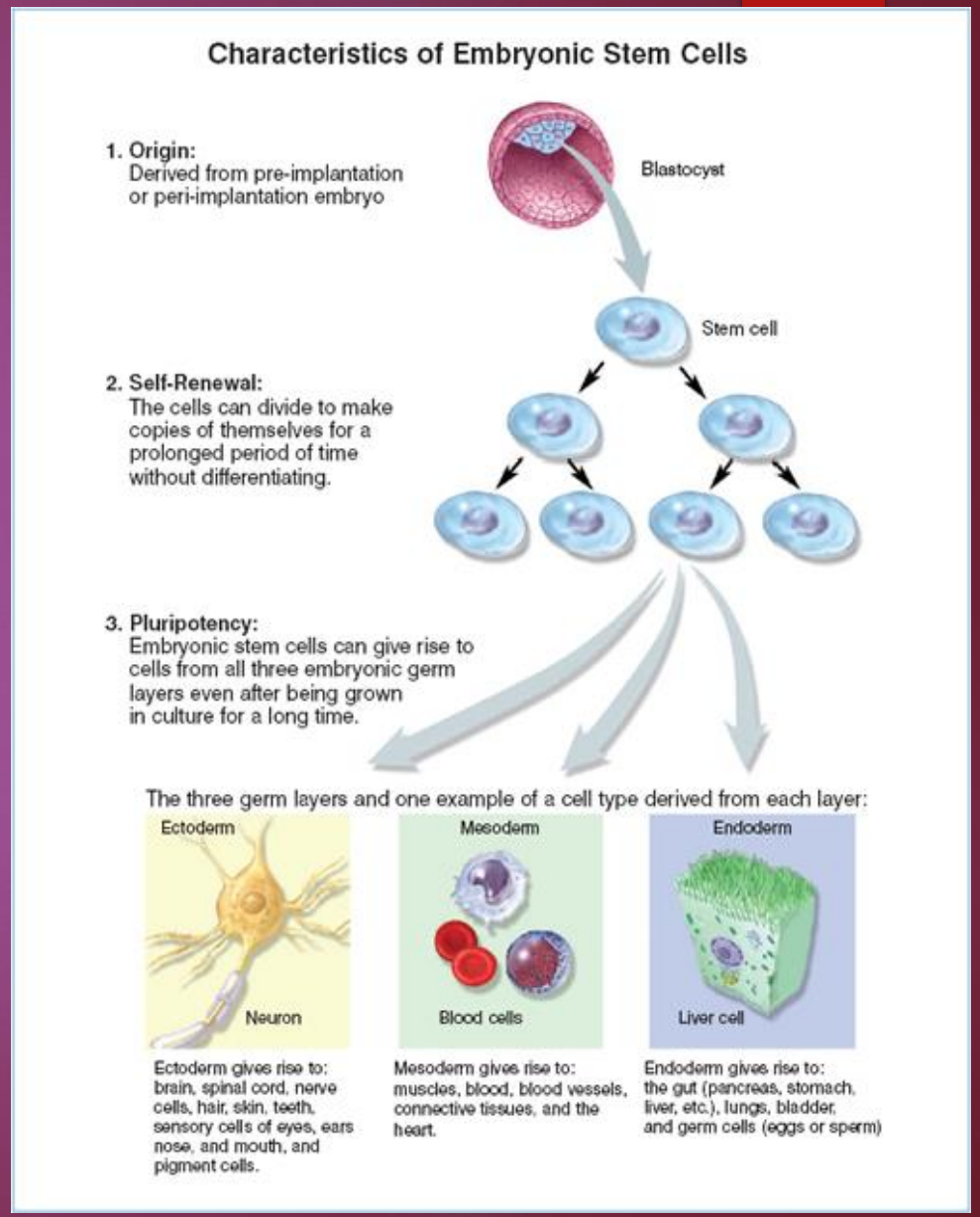
# Adult Stem Cells

- **Adult stem cells** are undifferentiated cells found throughout the body that divide to replenish dying cells and regenerate damaged tissues.
- These stem cells are found in small numbers in most adult tissues, such as bone marrow or fat.
- Adult stem cells are **multipotent**
- **Multipotent** cells can develop into more than one cell type, but are more limited than pluripotent cells



# Embryonic Stem Cells

- **Embryonic stem cells** These stem cells come from embryos that are three to five days old. At this stage, an embryo is called a blastocyst and has about 150 cells.
- These are pluripotent (ploo-RIP-uh-tunt) stem cells, meaning they can divide into more stem cells or can become any type of cell in the body.
- This versatility allows embryonic stem cells to be used to regenerate or repair diseased tissue and organs.
- They can become all three embryonic germ layers, ectoderm, mesoderm and endoderm.



CONNECTIONS + SCIENCE AND TECHNOLOGY

Stem Cells

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CAREER FOCUS

Midwife

Quiz 2 or Test!