Urogenital System

Sheet 4

Subject | physiology

Done by | Maryam Ali

Correction |Rawan Almujaibel

Doctor | Ebaa

Today we will discuss the **female reproductive system after pregnancy** . In the last lecture we discussed the female reproductive system before pregnancy and todat we will talk about the event after fertilization that occurred by the sperm. Our bjectives will be focusing on the stages of the fertilization by the sperm ,the dr said plz watch the vedio before you study this lecture:

https://www.youtube.com/watch?v=_5OvgQW6FG4

By the end of this lecture, you should be able to:

1- Describe fertilization.
2- Recognize the development and the function of the placenta.
3- Recognize the placenta as an endocrine organ.
4- Describe the physiological functions of placental hormones.
5- Explain the mother's physiological response to pregnancy.

Fertilization:

-As we discussed in the last lecture ovulation takes place in the ovaries when the primary oocyte enters the first stage of meiosis, it will give a secondary oocyte (23 unpaired chromosomes). Then, secondary oocyte will be ready for meiosis 2 once it fertilizes with a sperm, if there is no sperm reaches to the oocyte, it won't go through meiosis 2. so the ovaries will expel the oocyte while it is secondary oocyte with 23 unpaired chromosomes into the abdominal cavity during the ovulation process which is around 14^{th} day of the ovarian cycle (female sexual cycle). The ovum at this stage will be surrounded by part of the granulosa layers which is now called corona radiate and then it will enter the fallopian tube with the aid of fimbricated end of Fallopian tube. In the end of tube something called cilia that is move in presence of estrogen that is secreted by ovaries, then the ovum will be transported in the fallopian tube through the contraction of this smooth muscles of the fallopian tube and also with the aid of the cilia toward the ampulla of Fallopian tube.

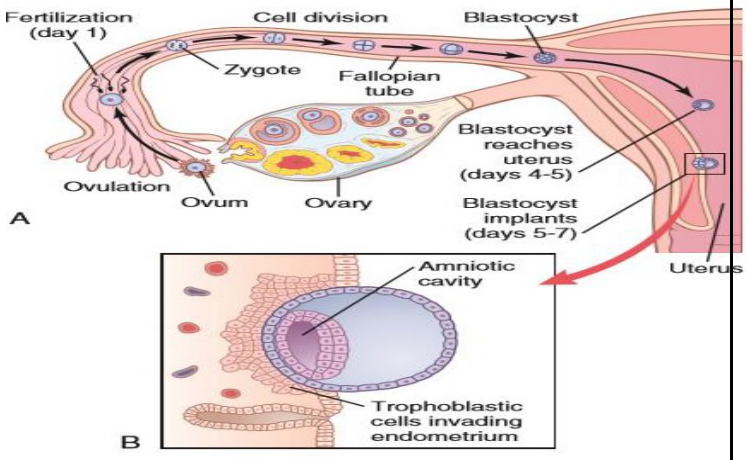
-At this stage, fertilization by the sperm will happen, the ovum will complete the second stage of meosis to complete the maturation of the ovum and then we will have again 23 chromsomes that are ready to compaine with the 23 chromosomes of the sperm (genatic material of the sperm)

The normal site of fertilization in the fallopian tube specifically in ampulla and after ejaculation sperms reach ampulla of fallopian tube within 30-60 min with the aid of present prostaglandin in the semen and ocyotoxin in the female to help the sperm reaching the ovum and fertilized it.

In the bottom we see a fertilized ovum that will be implanted in the uterus.

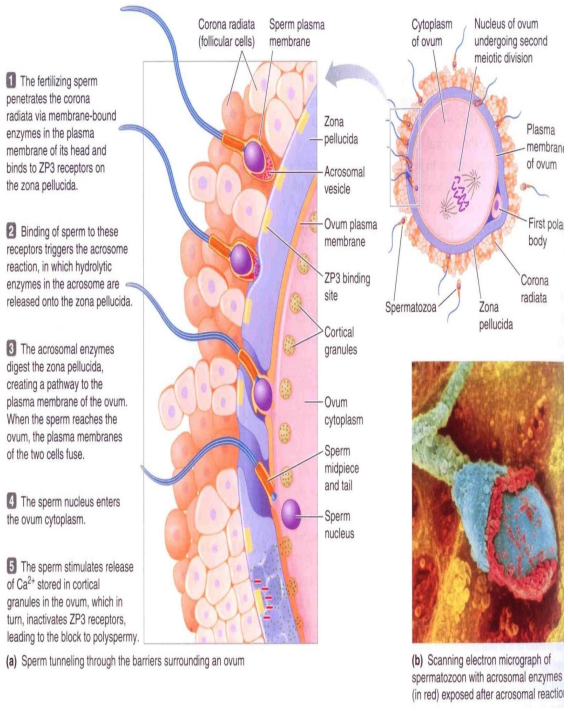
In the left figure, as you see in the cervix we have 3% of the sperms survived after 1-3 min of ejaculation . in uterus about 0.1% of sperms after 10-20 min after ejaculation , but in the fertilization site (the upper third of the duct) we have only 0.001% of sperms after 30-60 min of ejaculation .

Location	Time of appearance (min after ejaculation)	Percent of ejaculated sperm*
Fertilization site (upper third of oviduct)	30–60	0.001
Uterus	10–20	0.1
Cervical canal	1–3	3



Fertilization

1- The fertilizing sperm penetrates the corona radiateVia membrane-bound enzymes present in the pasma membrane of its head and binds to ZP3 receptor on the zona pelliucida
2- Binding of sperm to these receptors triggers the acrosome reaction, in which hydrolytic enzymes in the acrosome are released onto zona pellucida → zona pellucida is a layer is coverying the ovum after the corona radiate
3- The acrosomal enzymes digest the corona pellucida , creating a pathway to the plasma membrane of the ovum . When the sperm reaches the ovum , the plasma membranes of the two cells fuse.
4- The sperm nucleus only enters the ovum cytoplasm(but the midpiece and the tail won't emter the ovum)
5- The sperm stimulates release of ca+2 stored in cortical granules in the ovum , which in turn , inactivates ZP3 receptors . leading to block to

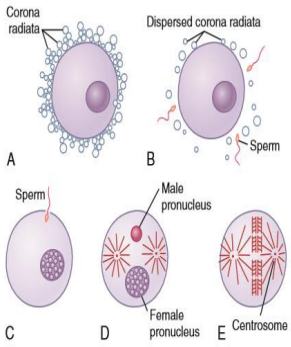


polysperm. (prevent any other sperm that want to penetrate the ovum , that why only one sperm will fertilize the ovum)

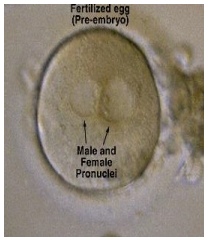
In the right figure , you will see how the nucleus of the sperm will compain with the genetic material of the ovum (nucleus of the ovum) . the figure in the bottom is showing the process that will have a pronucleus of male and female lined parallel to each others through a centromes that are found in each poles of the fertilized ovum → this stage is called complete union of sperm and ovum genetic materials.

- **FROM THE SLIDES:**

-Sperm penetrates **corona radiata and zona pellucida** (hyaluronidase)
-Oocyte divides to form **mature ovum** (female pronucleus 23 unpaired chr)
-Head of sperm swells (male pronucleus 23 unpaired chr)
-release of cortical granules preventing further sperm penetration
-Fertilized ovum (zygote) contains 23 paired chr→ 46 chromosomes.



This figure is showing the zygote → the ovum before the union of both male and female genetic materials:



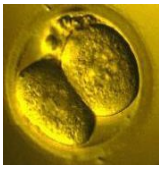
Cleavage

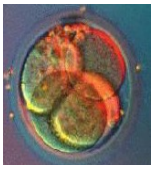
-Following fertilization, the zygote undergoes **several mitotic divisions** inside the zona pellucida (overall size does not change).

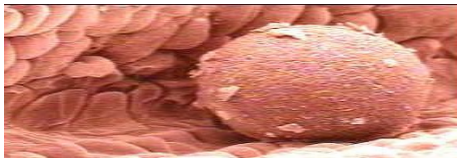
-1st cleavage yields a **2 celled embryo**,

-Each cell is **called a blastomere** and is totipotent

-Divisions continue rapidly **until the 32 cell stage**





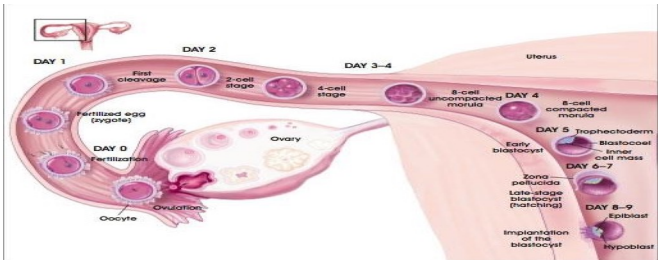


Traveling

-after that the travelling of fertilized ovum will take place across the fallopian tube and it finaly will reach the uterus to implant it into the lining of uterus

In the second figure , you will see the time line of fertilization and after fertilization stages

from day zero of fertilization until the completetion of fertilization (the zygote process) and at day one the first cleavage



will take place , when two cells are produced . At day 3-4 → 8 cells (uncompacted cell) its called morula cell.

At day 4 → 8 cells (compacted cell) which is also called morula cell.

At day 8-9 day → implantation occur of the fertilized ovum which is called epiblast

Transporte of fertilized ovum

-3-5 days after fertilization, the zygote reaches uterine cavity

-The transport of the fertilized ovum will be through :fluid current + action of cilia of fallopian tube+ weak contractions of the fallopian tube that will be aid through prostaglandin and estrogen

-Isthmus (last 2cm) relaxes under effect of progesterone→ that will aid the entrance of the fertilized ovum (zygote)to the uterus.

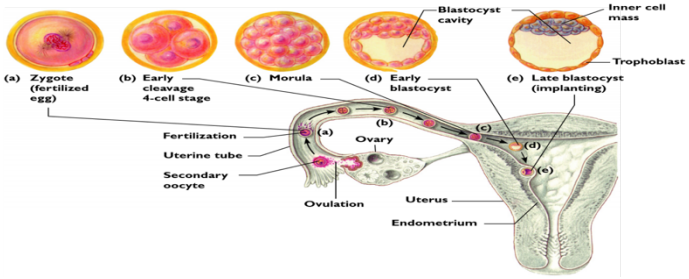
-Delayed transport allows cell division→ that happen before entering the uterus, at the stage when the blastocyte about 100 cells will enter the uterus.

Cleavage

In the figure, the early cleavage 4-cell stage which is called morula cell

Early blastocyte that will be implanted in the lining of the uterus (you will find blastocyst cavity).

Late blatcyst the exact implanted cell , that is composed of the trophoblast, the inner cell mass and trophoblast layer.



Implantation

-Trophoblastic cords from blastocyst that will be implanted and start to make the placenta.

-Blood capillaries grow in the cords from the fertilized ovum

-21 days after fertilization, blood starts to be pumped by fetal heart into the capillaries

- At the same time Maternal blood sinuses develop around the trophoblastic cords from the implanted zygote

-More and more trophoblast projections develop → which will form → (placental villi)

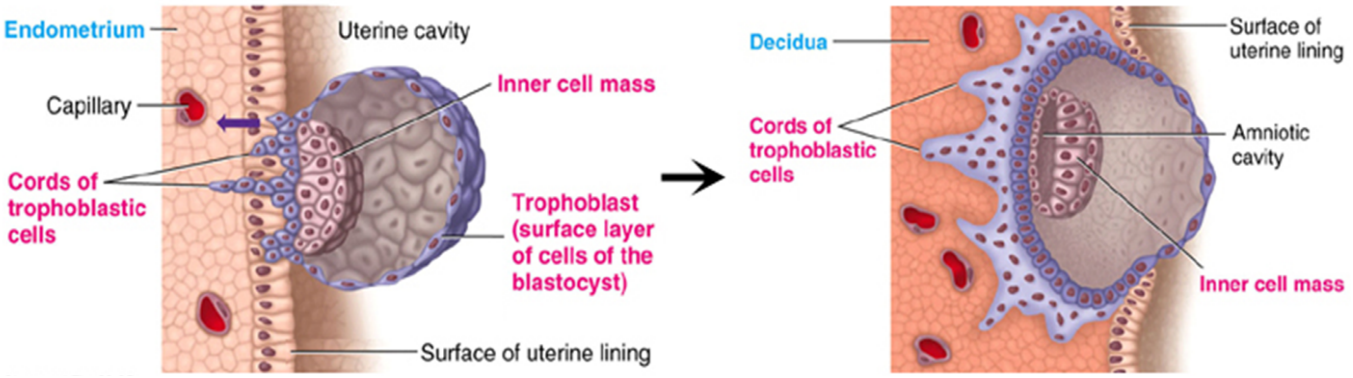
See the figure in the next page:

*Endometrium(the lining of the uterus)→ that the trophoblast (surface kayer of the blastocyte) invade into it→ forming cords of trophoblastic cells (then it will grow)

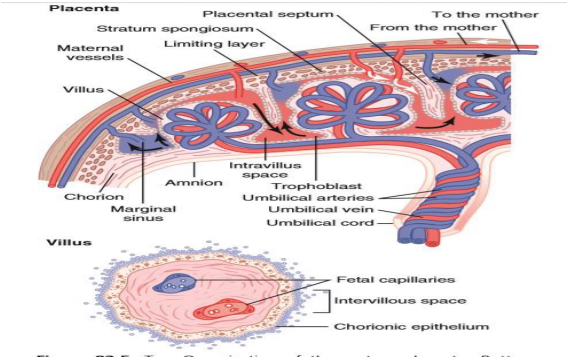
*Decidua → the endometrial part after the implantation (it is maternal part).

*Amniotic cavity will be formed at this stage (implantation stage).

*Inner mass cell → will form the embryo



Placenta



Is the primary source of nutrition and gases for the developing fetus begaining of the 8 week of gestation .

Bfore that the develoing ovum will get nutrients from the secretion of the fallopian tube that aid with progesterone hormone as well as in the uterian milk will provide the developing and dividing ovum under the effect of progesterone and after implantation the blactocyte will get its nutrition from endometrisl lining of the uterus that has stored many of the nutrients such as lipids , glycogen by the action of the progesterone during the ovulation cycle . The implanted ovum will keep getting its nutrition through this pathaway until the 8th week of the gestation that will be through the placenta,

NOTE: even that the placenta starts earlier at the 16 day after fertilization to provide the fetus the nutrition but mainly it starts at the 8th week of gestation .

In developed placenta, Fetus's blood flows through two umbilical arteries (carry unoxygenated blood), then into the capillaries of the villi, and finally back through a single umbilical vein (carry oxygenated blood) into the fetus. At the same time, the mother's blood flows from her uterine arteries into large maternal sinuses that surround the villi and then back into the uterine veins of the mother.

NOTE : **sinuses → in the maternal side**

Villi→ in the fetus side

The sinuses will be surrounded by villi to exchange the gases between mother and fetus.

*so the exchange through the placenta is very similar to that exchange that takes place in the pulmonary and others cappalaries body in our bodies

Main functions of the placenta:

1-Respiration→to provide the fetus oxygen

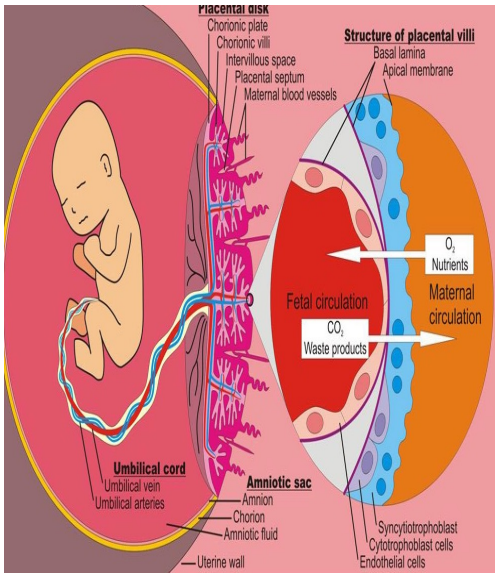
2-Nutrition→ to provide the fetus With the needed nutrients such as amino acids , sugars, etc

3-**Excretion**→ to excrete the waste product from metabolic reaction of metabolism of hormones and metabolized products.

4-Endocrine→ for the mother and the fetus

5-protection→for the fetus

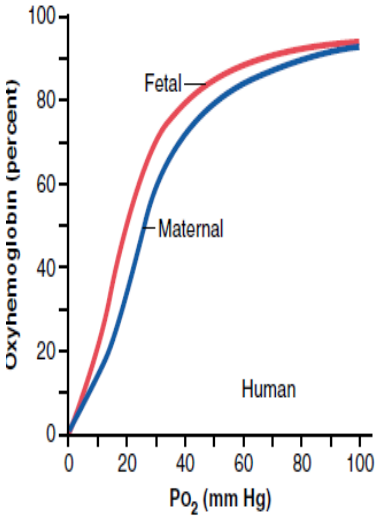
***you can see how the maternal bllod and the fetus blood how is releated to each others to provide the oxygen and the nutrition from the maternal ciculationto the fetus circulation and for the weasting products will be eliminated (co2, wasting product) from the fetus circulation to the matermal circulation through a specific elimination pathways**



Important factors facilitating delivery of oxygen from the maternal circulation to the fetus tissuses

1-Difference in pO2 (concentration) between maternal and fetal blood

(mother pO2 (50mmgh) > fetus pO2(30mmgh))→ as we see there is no big difference between them (20mmgh), but it is sufficient to transport the o2 to the fetus tissues by another factors



2-High fetus haemoglobin (HbF)(16 - 17 g/dl) which has high affinity (tendency) for O2 than mother's haemoglobin (HbA) → that lead to shifted the fetal hemoglobin to left, and the maternal hemoglobin shifted to the right

NOTE: At the low Po2 levels in fetal blood, the fetal hemoglobin can carry 20 to 50% more oxygen than maternal hemoglobin can

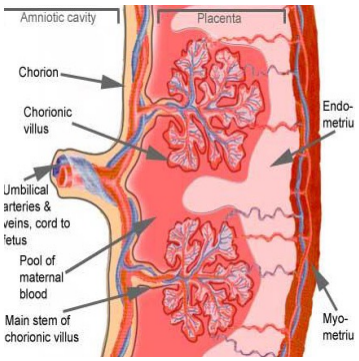
3-High fetal cardiac output → due to the both ventricle compenation due to the shunting process of the cardiac fetus

4-Double Bohr Effect → takes place in both the maternal and fetus circulations

*when there is low conc. Of co2 → there will be high tendency to bind o2 to hemoglobin, and the opposite is true, so it will dissociate whn then rhere is high level of co2 (the opposite is true as well).

- fetal side → high pco2 → leading to dissociate o2 → more alkaline blood (more tendency to combined to oxygen.

- mother side → when the co2 reached the maternal side through diffusion according its gradient → leading to have an acidic blood that will dissociate the o2 and transport it to the fetus



-High pH in fetal blood (alkaline)

-Low pH in mother's blood (acidic)

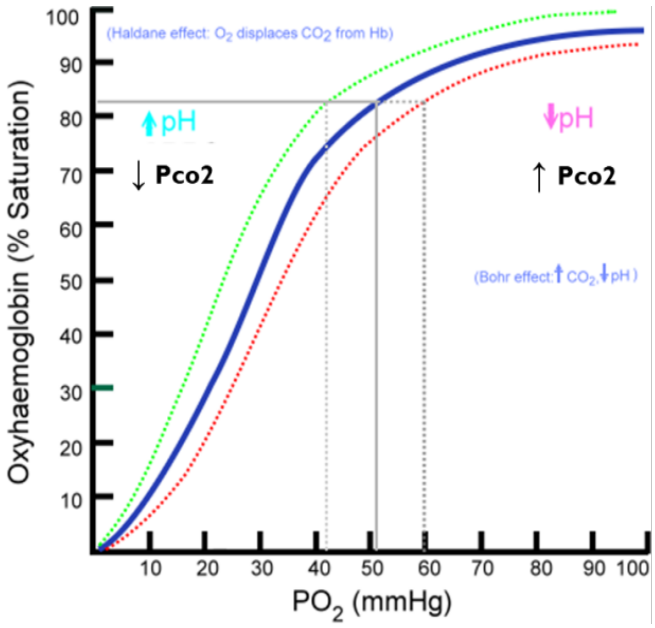
Explaining the bohor effect through the o2 disociation curves : (respiration)

- **In placenta:**

-The maternal blood gains CO2 from the fetus, the pH falls and the curve shifts to the right releasing additional oxygen.

-On the fetal side of the placenta CO2 is lost (to the maternal), the pH rises and the curve shifts to the left allowing additional oxygen uptake.

- NOTE Hemoglobin can carry more oxygen at a low Pco2 than it can at a high Pco2



Nutrition

-Fetus uses mainly glucose for nutrition so the trophoblast cells in placental villi transport glucose by carrier molecules; GLUT (facilitated diffusion) →(these transporters are found in the trophoblast)

-Fatty acids diffuse due to high solubility in cell membrane (more slowly than glucose)→ due to availability of the transporters of the glucose on the trophoblast.

-The placenta have active transports for amino acids, with fetal concentrations exceeding maternal levels.-
-> that why we have the active transporter not ONLT the passive transporter

-K+, Na+ and Cl- diffuse from maternal to fetal blood with bulk diffusion → just like any cappallarie

Excretion

-Excretory products of the fetus diffuse through the placental membrane to maternal blood to be excreted with the waste products of the mother via renal system such as Urea, uric acid and creatinine.

-Higher conc. of excretory products in fetal blood ensures continuous diffusion of these substances to the maternal blood→ due to the different conc. We will have continuose diffusion of products which are proteins, waste products or muscles metabolisms.

Best of luck