PHYSIO

MODIFIED NO. 17

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وَقُل رَّبِّ
أَدۡخِلۡنِي مُدۡخَلَ صِدۡقٖ
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NOTES

Notes under the slides from doctor will be in this box

Color code

- Slides
- Doctor
- Additional info
- Important

Pregnancy and Lactation

Chapter 83

Response of the Mother's Body to Pregnancy

Weight Gain in the Pregnant Woman

- The average weight gain during pregnancy is about 10 to 15 kg.
- Most of this gain occurring during the last two trimesters.
- Weight due to: Fetus 3.5 kg, amniotic fluid 1.5 kg, placenta, and fetal membranes.
- Uterus and breasts increase in size, to prepare for lactation after labor.
- Extra fluid in the blood and extracellular fluid. During Pregnancy, most hormones increased secretion from anterior pituitary; like ACTH that increases aldosterone and cortisol secretion from adrenal gland. High Aldosterone would cause retention of fluids and increase ↑ Na reabsorptions and K+ secretion.
- Fat accumulation. This due to increased appetite as there is high metabolism due to thyroid hormone.

DOCTOR NOTES

- The extra fluid is excreted in the urine during the first few days after birth—that is, after loss of the fluid-retaining hormones from the placenta.

- During pregnancy, a woman often has a greatly increased desire for food, partly as a result of removal of food substrates from the mother's blood by the fetus and partly because of hormonal factors.

- Without appropriate prenatal control of diet, the mother's weight gain can be as great as 75 pounds

- instead of the usual 25 to 35 pounds.

Metabolism During Pregnancy

- As a consequence of the increased secretion of many hormones during pregnancy, including **thyroxine**, **adrenocortical hormones**, and the **sex hormones** (progesterone and estrogen),
- the basal metabolic rate of the pregnant woman **increases about 15%** during the **latter half** of pregnancy.
- Thyroid hormone: ↑ increases basal metabolic rate, which is rate at which the body uses energy while at rest + responsible for body's temperature (Calorigenic production)

- Extra load → **greater** amounts of energy for **muscle activity**.
- **Overheated sensation.**

Endocrine glands

- As a response to **increase basal metabolic rate** and **placental hormones.**
- The **anterior pituitary** gland of the mother **enlarges** at least **50%** during pregnancy
- Increases its production of **(ACTH), TSH, and prolactin**.

- Exception: **FSH and LH** are almost totally **suppressed** as a result of the inhibitory effects of estrogens and progesterone from the placenta. This due to the body doesn't need to stimulate the ovaries to release eggs.

- Increase glucocorticoid and aldosterone secretion.
- Increase thyroid gland **size** and T4 production.

Endocrine glands-- Increased Parathyroid Gland Secretion

- The mother's parathyroid glands usually **enlarge** during pregnancy.
- Parathyroid Increases **calcium absorption** from the mother's **bones**, thereby maintaining normal calcium ion concentration. In addition, Increases production of Calcitriol (active vitamin D) that increases calcium reabsorption in GIT and kidney.

- While the **fetus** removes calcium from maternal circulation to **ossify its own bones**.

- This secretion of parathyroid hormone is even **greater** during **lactation** because the growing baby requires many times more calcium than does the fetus.

Nutrition During Pregnancy

- As there a new human is developing inside her womb, the mother's storage are low. During first weeks of pregnancy, Nausea, vomiting and GI disturbances that decreases its appetite.

- Ordinarily, the mother does not absorb sufficient protein, calcium, phosphates, and iron from her diet during the last months of pregnancy to supply these extra needs of the fetus.

- However, in anticipation of these extra needs, the mother's body has already been storing these substances—some in the placenta, but most in the normal storage depots of the mother.

- Diet needs to have: Iron, vitamin D, folic acid, and vitamin K

DOCTOR NOTES

- By far the greatest growth of the fetus occurs during the last trimester of pregnancy; its weight almost doubles during the last 2 months of pregnancy.

- Without sufficient iron in her food, a pregnant woman usually develops *hypochromic anemia*.

- Also, it is especially important that she receive vitamin D, because although the total quantity of calcium used by the fetus is small, calcium is normally poorly absorbed by the mother's gastrointestinal tract without vitamin D.

- Folic acid is given before pregnancy and during first 3 months so that we prevent any neurodegenerative diseases.

- Finally, shortly before birth of the baby, vitamin K is often added to the mother's diet (green leaflets) so that the baby will have sufficient prothrombin to prevent hemorrhage , particularly brain hemorrhage, caused by the birth process.

Blood Flow Through the Placenta and Maternal Cardiac Output Increase During Pregnancy

- ↑ Blood flow through the maternal circulation of the placenta
- ↑ Mother's metabolism
- ↑ Mother's cardiac output to 30% to 40% above normal by the 27th week of pregnancy till 40 weeks.

DOCTOR NOTES

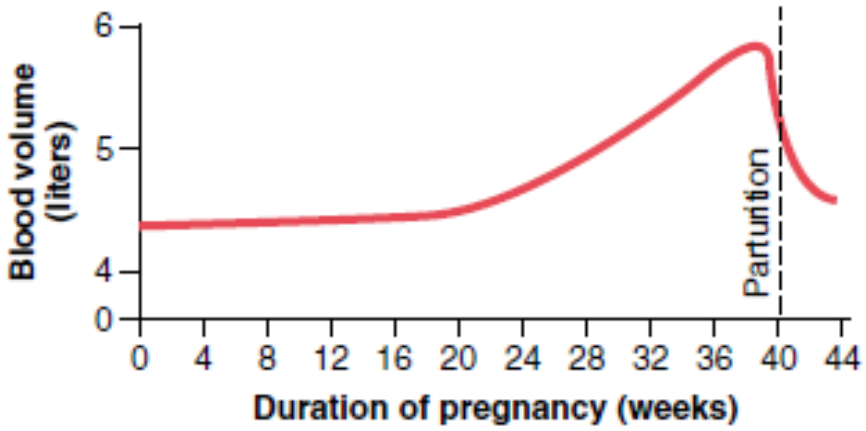
- ~625ml/min of blood into the placenta>>> increase cardiac output
- for reasons unexplained, the cardiac output falls to only a little above normal during the last 8 weeks of pregnancy, despite the high uterine blood flow

Maternal Blood Volume Increases During Pregnancy

- The maternal blood volume shortly before term, it will increase about 30% above normal. This is important as during labor there would be loss of blood.
- The cause: aldosterone –reabsorption of Na and water - and estrogens
- Increased fluid retention by the kidneys.
- In addition, the bone marrow becomes increasingly active and produces extra red blood cells to go with the excess fluid volume.

DOCTOR NOTES

- Therefore, at the time of the birth of the baby, the mother has about 1 to 2 liters of extra blood in her circulatory system.
- Only about 350 ml is normally lost through bleeding during delivery of the baby, thereby allowing a considerable safety factor for the mother.



Maternal Respiration Increases During Pregnancy

- **Increased basal metabolic rate** + **greater size** → the total amount of **oxygen** used by the mother is about **20% above normal**
- These effects cause the mother's minute ventilation to increase.
- Pressing the diaphragm, **less space** → the **respiratory rate** is **increased** to maintain the extra ventilation.
- High levels of **progesterone** increases the **sensitivity** of the respiratory center to **carbon dioxide.**

Maternal Kidney Function During Pregnancy

- Increased urination → because of increased fluid intake and increased load of excretory products. In addition, compression of the urinary bladder by the enlarging uterus, leading to reduced bladder capacity.

- The renal tubules' reabsorptive capacity for sodium, chloride, and water is increased.

- The renal blood flow and glomerular filtration rate as a result of renal vasodilation (relaxin).

Labor

Increased Uterine Excitability Near Term

- *Parturition* means birth of the baby

(1) progressive hormonal changes that cause increased excitability of the uterine musculature.

(2) progressive mechanical changes.

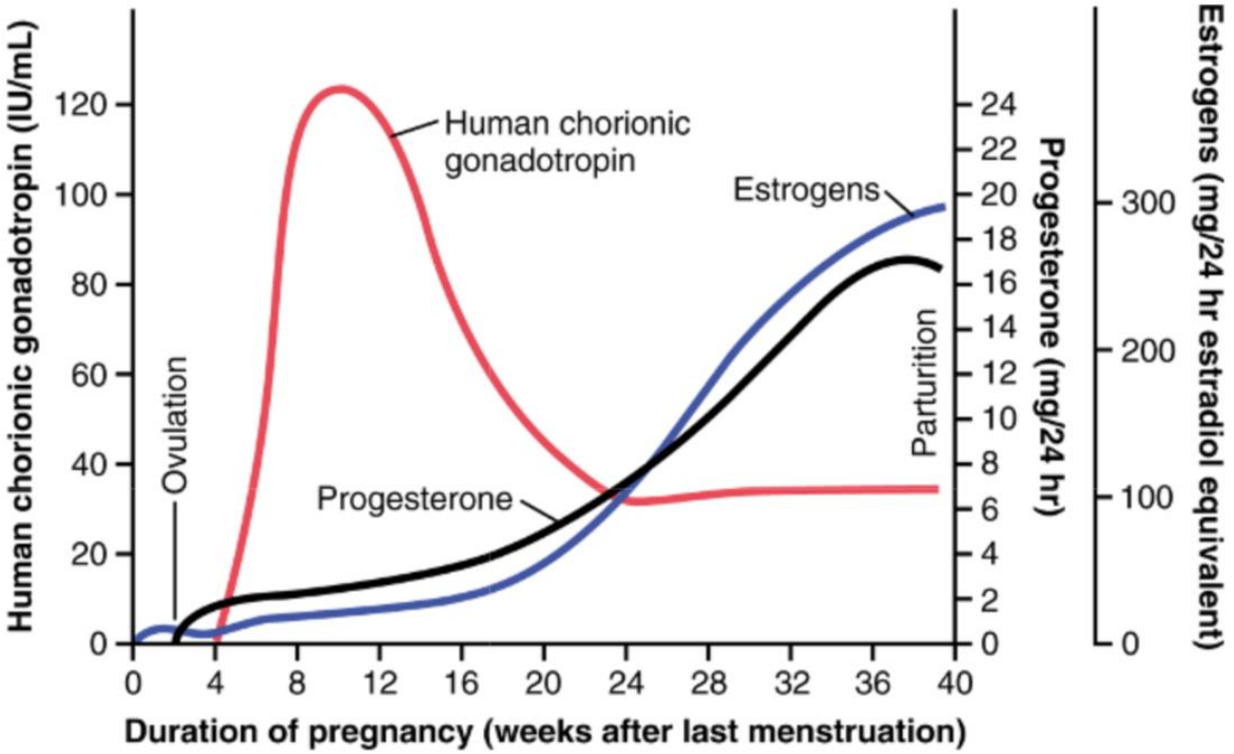
DOCTOR NOTES

- *Parturition* means birth of the baby. Toward the end of pregnancy (from week 37 to 40), the uterus becomes progressively more excitable, until finally it develops such strong rhythmical contractions that the baby is expelled.
- The exact cause of the increased activity of the uterus is not known, but at least two major categories of effects lead up to the intense contractions
- Preterm labor starts before 37 weeks of pregnancy and full term labor lasting between 39 weeks and 40 weeks

Hormonal Factors That Increase Uterine Contractility

Increased Ratio of Estrogens to Progesterone

- The estrogen-to-progesterone ratio increases sufficiently toward the end of pregnancy (from week 28 onward) to be at least partly responsible for the increased contractility of the uterus.



NOTES

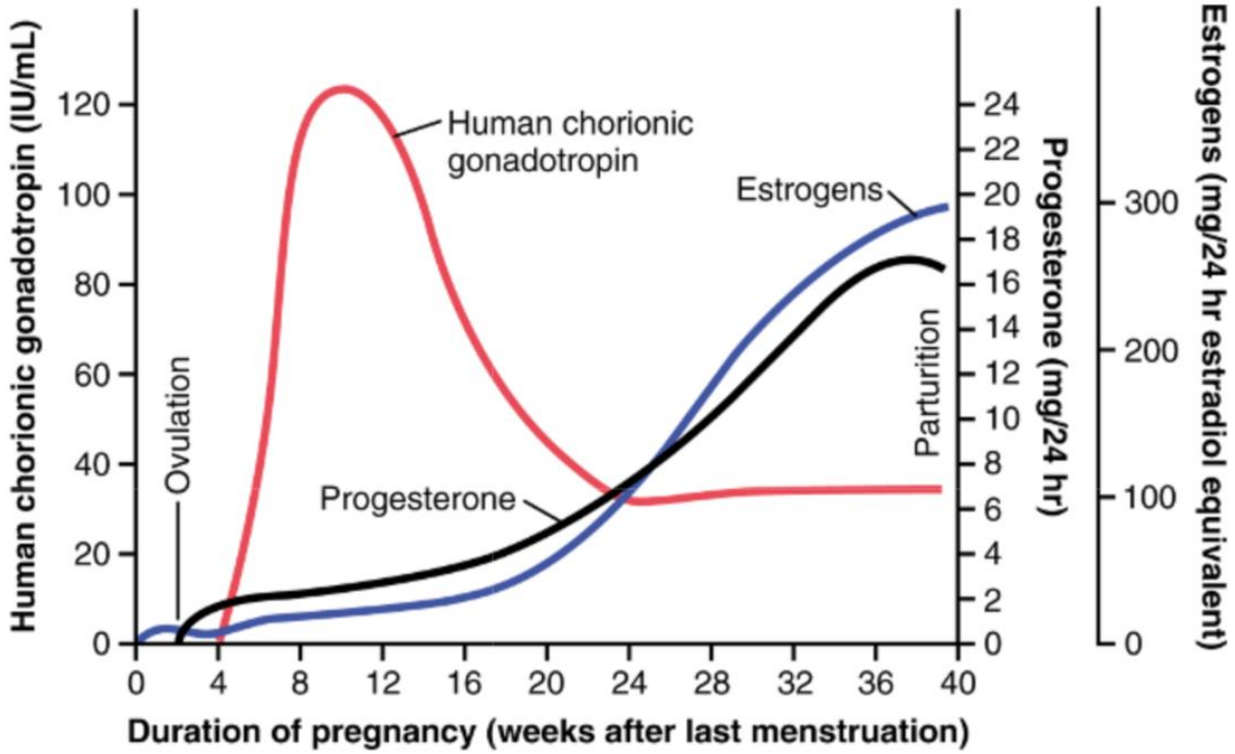
- Estrogens increase the number of gap junctions between the adjacent uterine smooth muscle cells

Increased Ratio of Estrogens to Progesterone

This diagram shows the hormonal changes during pregnancy over time

- In first trimester, Human chronic gonadotropin (hCG) Rises and then Declines. . Throughout this period, the ratio of progesterone to estrogen is high, which helps to relax the uterus.

- During the end of pregnancy (28 week), estrogen > progesterone ratio increases. This change enhances the contractility of the uterus by

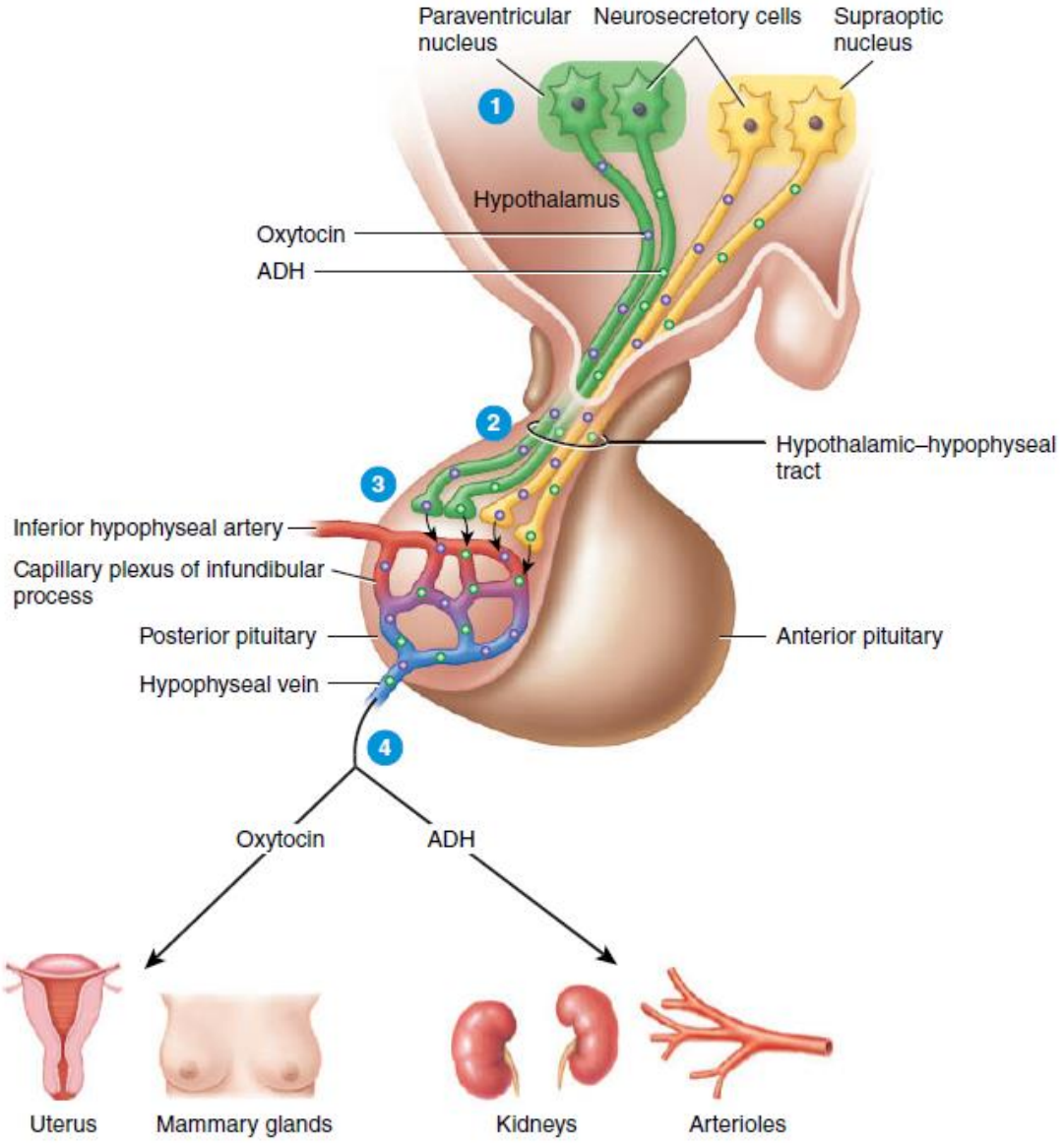


increasing the number of oxytocin receptors

+ loosening of ligaments to allow for uterine dilatation

Oxytocin - most important hormone in labor

- 1. The uterine muscle increases its oxytocin receptors during the latter few months of pregnancy.
- 2. Oxytocin secretion rate is increased at the time of labor.
- 3. Labor is prolonged in hypophysectomized (removal of the pituitary gland)animals .
- 4. Irritation or stretching of the cervix cause an increase in oxytocin secretion (Positive feedback).
- + Fetal Hormones!



- oxytocin helps push and dilate the cervix, allowing the baby to pass through the birth canal.
- Positive feedback process is important in labor. Uterine contractions push the baby's head against the cervix → cervical stretch is sensed → stimulates more oxytocin release from posterior pituitary → stronger contractions and more dilatation.

DOCTOR NOTES

Effect of Fetal Hormones on the Uterus

- The fetus's pituitary gland secretes increasing quantities of oxytocin, which might play a role in exciting the uterus.
- Also, the fetus's adrenal glands secrete large quantities of cortisol, another possible uterine stimulant.
- In addition, the fetal membranes release prostaglandins in high concentration at the time of labor. These prostaglandins, too, can increase the intensity of uterine contractions.

Mechanical Factors That Increase Uterine Contractility

Now, how will the previous hormonal processes influence the upcoming mechanical factors? Continue reading and you shall see... 😺 👓

Mechanical factors

Contraction of the uterus + stretching and dilatation of the cervix

- **Stretch of the Uterine Musculature**
- The smooth muscles have their own reflex; stretching of smooth muscles usually increases their contractility.

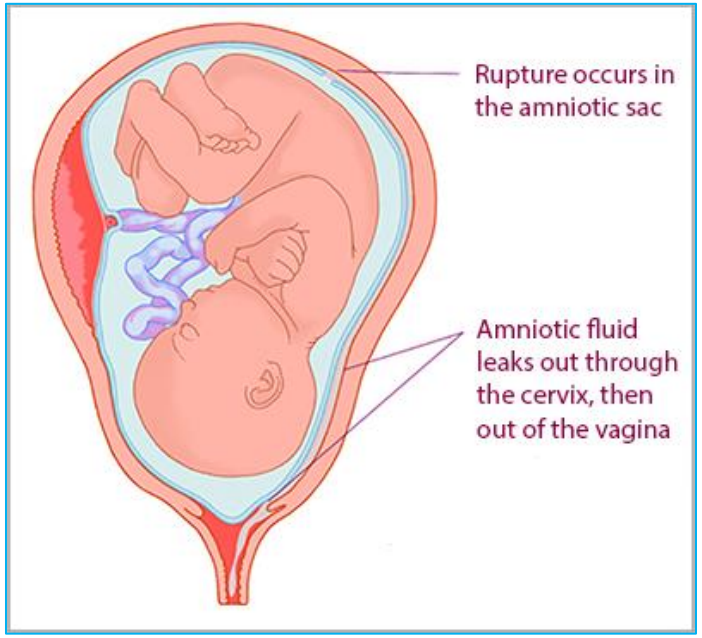
- **Stretch or Irritation of the Cervix → the most important step during labour!!**
- The cervix has to dilate 10cm in diameter, reaching what we call "full dilatation" allowing the baby's head to exit
- Obstetricians frequently induce labor by rupturing the membranes so the head of the baby stretches the cervix more forcefully.

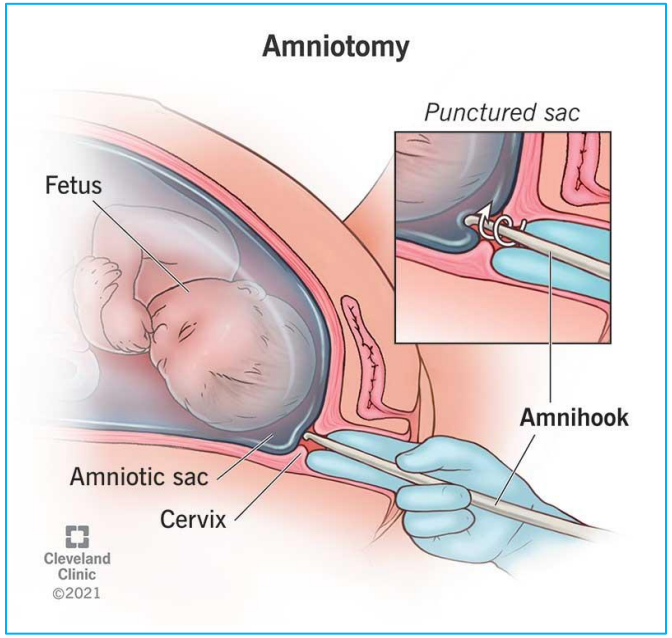
DOCTOR NOTES

These reflexes are especially noticed when twins are born, on average, 19 days earlier than a single child, which emphasizes the importance of mechanical stretch in eliciting uterine contractions (more weight exerts more stretch in the uterus, eliciting contractions earlier)
stretching or irritation of nerves in the cervix initiates reflexes to the body of the uterus,
OR result simply from myogenic transmission of signals from the cervix to the body of the uterus.

The success of the cervical dilatation process is time-sensitive; if dilatation doesn't occur at the proper time, labour complicates.
What some obstetrics do in this case is that they induce cervical dilatation by **rupturing the amniotic membrane** that surrounds the fetus, which causes leaking of the amniotic fluid, therefore dilating the cervix as a result.

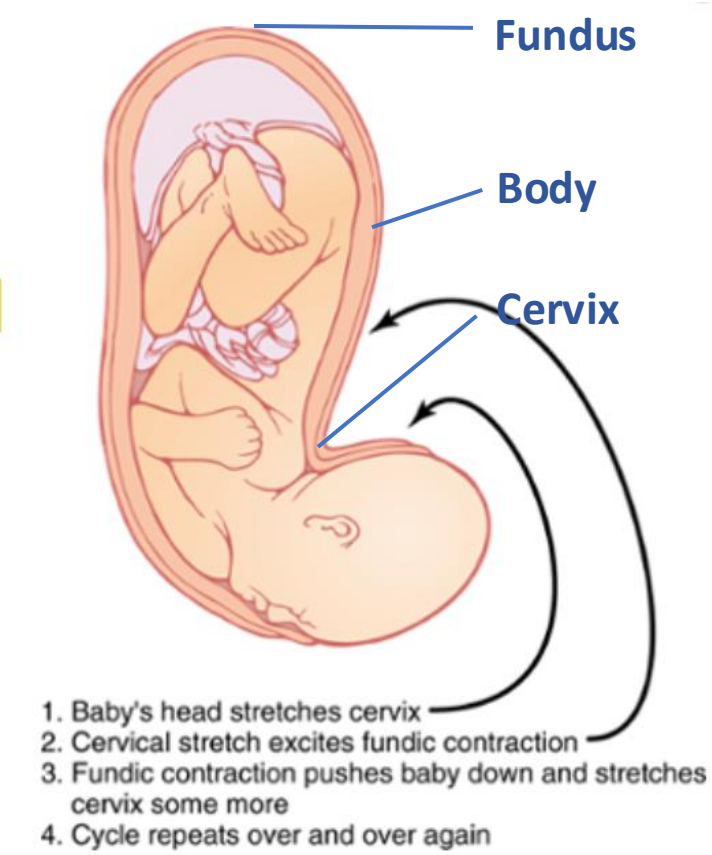
EXTRA IMAGES 💡





Onset of Labor—A Positive Feedback Mechanism for its Initiation

- The positive feedback theory suggests that **stretching** of the **cervix** by the **fetus's head** finally becomes **great enough** to elicit a strong reflex increase in **contractility of the uterine body**.
- This pushes the baby forward, which stretches the cervix more and initiates more **positive feedback** to the uterine body.
- The process repeats until the baby is expelled.



Further contractions caused by positive feedback must be stronger than preceding ones in order to keep the nervous system activated, for the secretion of more oxytocin. Therefore, allowing more contractions to take place.
This is the basis and purpose of a positive feedback cycle, which persists till we reach full cervical dilatation.

DOCTOR NOTES

**(1) Stretching of the cervix causes the entire body of the uterus to contract, and this contraction stretches the cervix even more because of the downward thrust of the baby's head.
(2) Cervical stretching also causes the hypothalamus and the posterior pituitary gland to secrete oxytocin, which is another means for increasing uterine contractility.

**Remember that for a positive feedback to continue, each new cycle of the positive feedback must be stronger than the previous one. If at any time after labor starts some contractions fail to re-excite the uterus sufficiently, the positive feedback could go into a retrograde decline, and the labor contractions would fade away.

Again, it's all time-bound; these contractions must happen in the proper time window and should be regular. That is, they should become stronger in intensity and more frequent (increasing in rate, for example: taking place every 5 minutes, then every 4 minutes, 3, 2, 1... until delivery is successfully achieved. ✅

Abdominal Muscle Contractions During Labor

- Once uterine contractions become strong during labor → pain signals → elicit neurogenic reflexes → to the abdominal muscles → causing intense contractions.
- The abdominal contractions add greatly to the force that causes expulsion of the baby

Sometimes, during delivery, the mother is asked to "push" so that she exerts pressure on the uterus and perineal area using her abdominal muscles.
💢**Pain signals** aid in this process by sending neurological signals to the abdominal muscles.
So, a mother on epidural anesthesia (doesn't feel pain) is guided by the nurse to know when to contract her abdominal muscles simultaneously with the uterine contractions taking place.

Stages of Labor

- The first stage lasts from the onset of **true labor** (contractions, increasing in frequency) to complete dilation of the cervix.
- The second stage spans from complete dilation of the cervix to the birth of the baby.
- The third stage lasts from the birth of the baby to delivery of the placenta.
- The fourth stage spans from delivery of the placenta to stabilization of the patient's condition, usually at about 6 hours postpartum.

*The placenta has to be delivered along with the baby.

DOCTOR NOTES

**It is fortunate that the contractions of labor occur intermittently, because strong contractions impede or sometimes even stop blood flow (hypoxia) through the placenta and would cause death of the fetus if the contractions were continuous. Indeed, overuse of various uterine stimulants, such as oxytocin, can cause uterine spasm rather than rhythmic contractions and can lead to death of the fetus.

Separation and Delivery of the Placenta

- Separation of the placenta opens the placental sinuses and causes bleeding (350 ml). Again, that's why a pregnant woman's body is characterized by increased blood volume; to compensate for the loss that's going to occur during labour.
- Contraction of the uterus after delivery of the baby constricts the vessels that had previously supplied blood to the placenta.
- Vasoconstrictor prostaglandins formed at the placental separation site.

DOCTOR NOTES

** For 10 to 45 minutes after birth of the baby, the uterus continues to contract, which causes a shearing effect between the walls of the uterus and the placenta, thus separating the placenta from its implantation site.

Once the baby's out and the umbilical cord is clamped, the blood supply will be cut from the placenta and vasoconstriction happens at the separation site due to **prostaglandins** taking action there.

Labor pain

there are 2 types of pain caused by different reasons in different stages

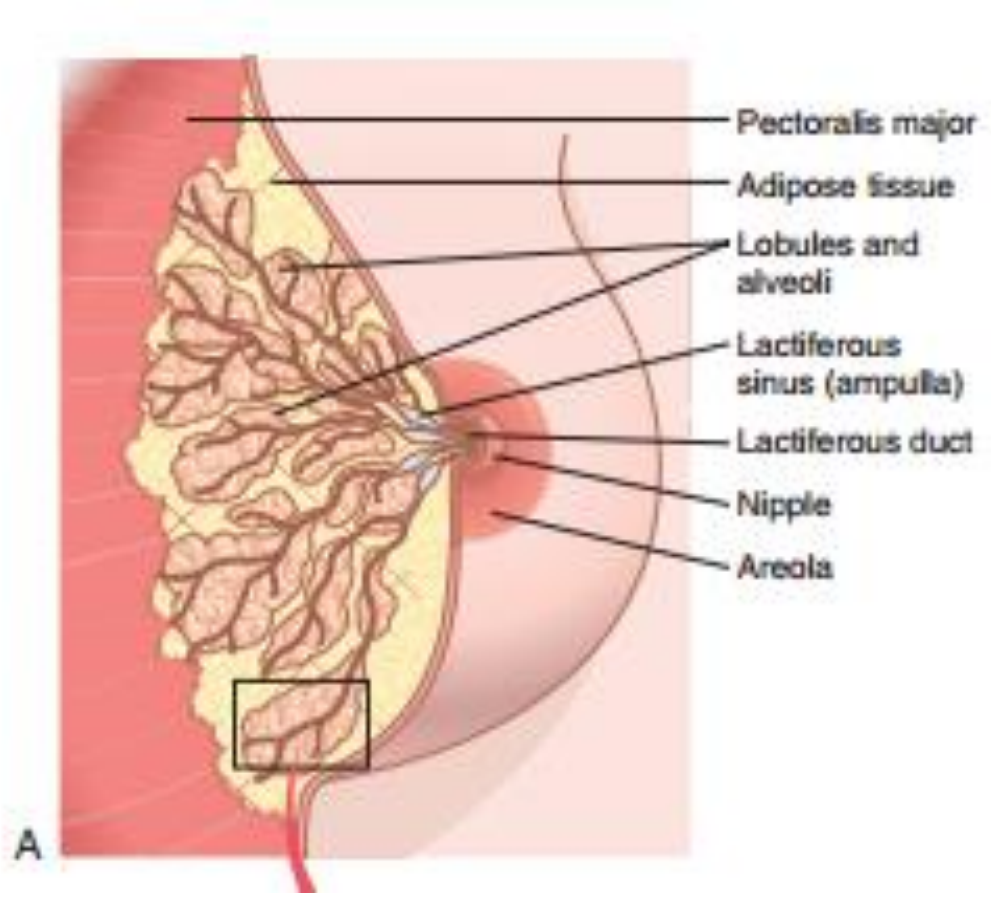
- In **early labor** (contractions, vasospasms) is probably caused mainly by **hypoxia** of the uterine muscle resulting from compression of the blood vessels in the uterus. ➞ **visceral pain,** referred in the abdomen and lower back.
- During the **second stage** of labor, when the fetus is being expelled through the birth canal, much more severe pain is caused by **cervical stretching**, **perineal stretching**, and **stretching or tearing of structures in the vaginal canal itself**. ➞ **parietal pain,** more localized, not vague (unlike the previous visceral pain).

Lactation

In the previous lectures, we talked about estrogen being the hormone responsible for the development of a female's body from its child's form to an adult's. Now, we'll discuss how it plays a role specifically in the breast development, by fat deposition and development of the ductal system. (القنوات الحليبية)

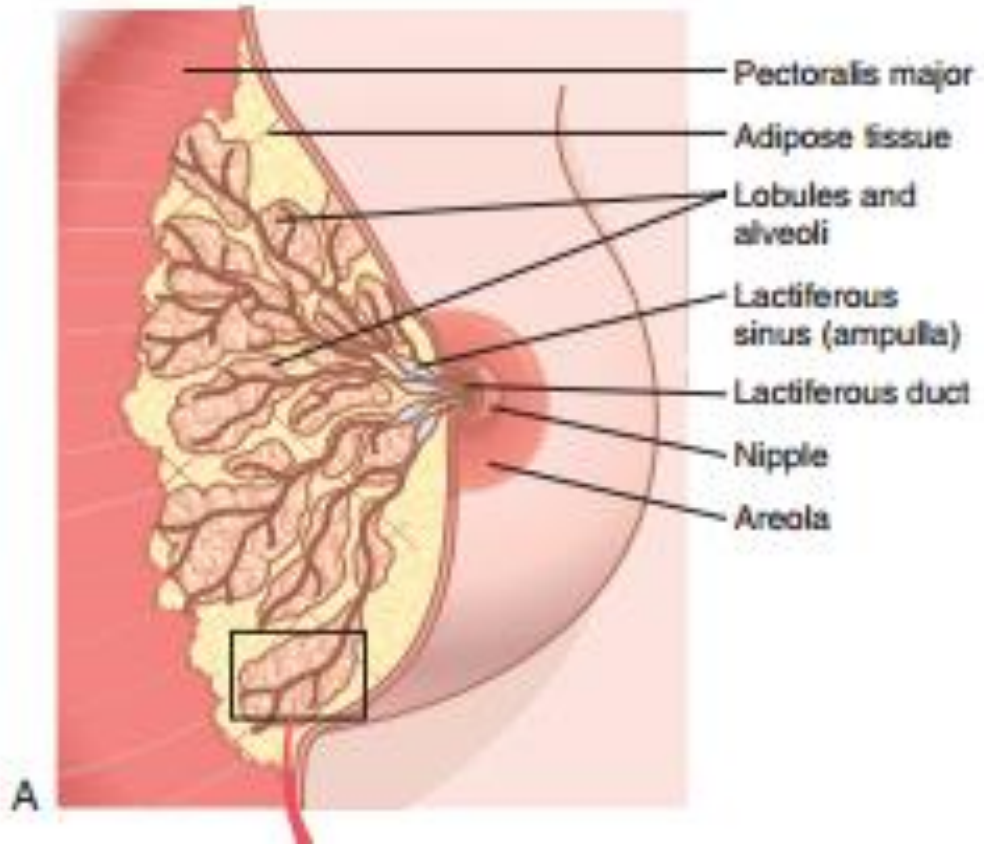
Development of the Breasts

- The breasts development begins at puberty. (estrogens)
- Estrogens stimulate growth of the breasts' mammary glands plus the deposition of fat to give the breasts mass.
- Far greater growth occurs during pregnancy, and only then does the glandular tissue become completely developed for production of milk.



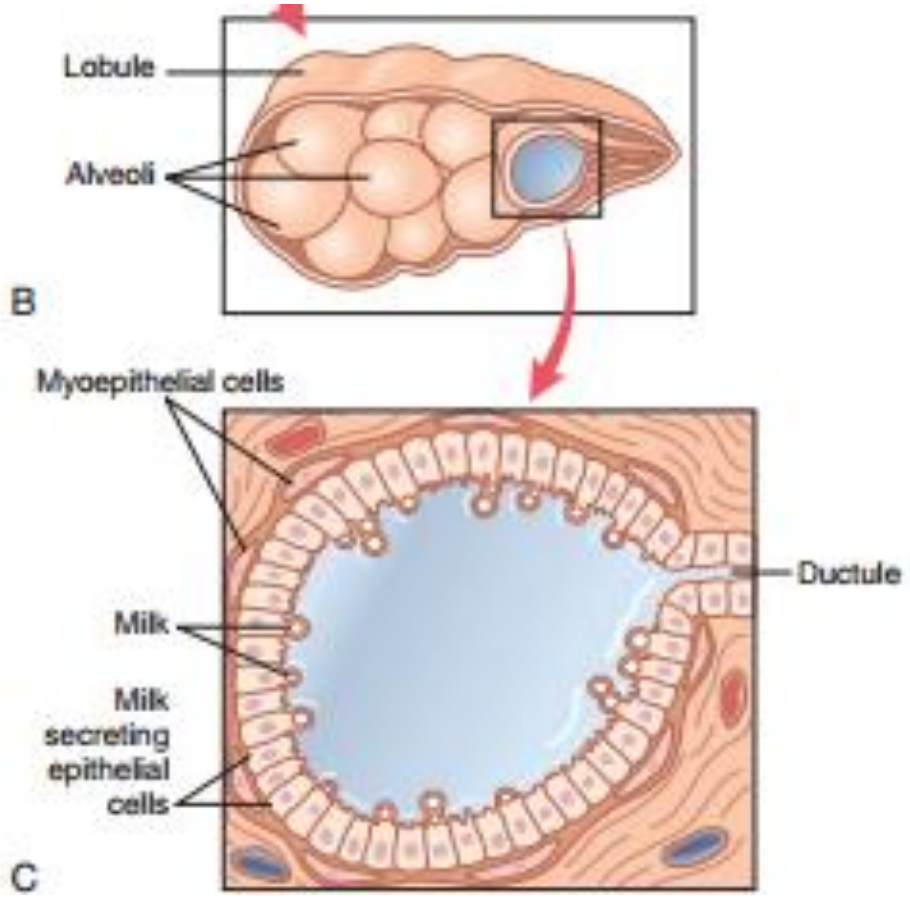
Estrogen Stimulates Growth of the Ductal System of the Breasts

- All through pregnancy, the large quantities of estrogens cause the ductal system of the breasts to grow and branch.
- The stroma of the breasts increases in quantity, and large quantities of fat are laid down in the stroma.
- For the development of breast tissue during pregnancy, estrogen doesn't work solo, it works together with: growth hormone, prolactin, adrenal glucocorticoids, and insulin. (team work!! 🌟)



Progesterone Is Required for Full Development of the Lobule-Alveolar System

- Final development of the breasts into milk-secreting organs also requires progesterone.
- Progesterone causes additional growth of the breast lobules, with budding of alveoli and development of **secretory characteristics** in the cells of the alveoli.
- These alveoli contain the milk-producing epithelial cells surrounded by myoepithelial cells that contract



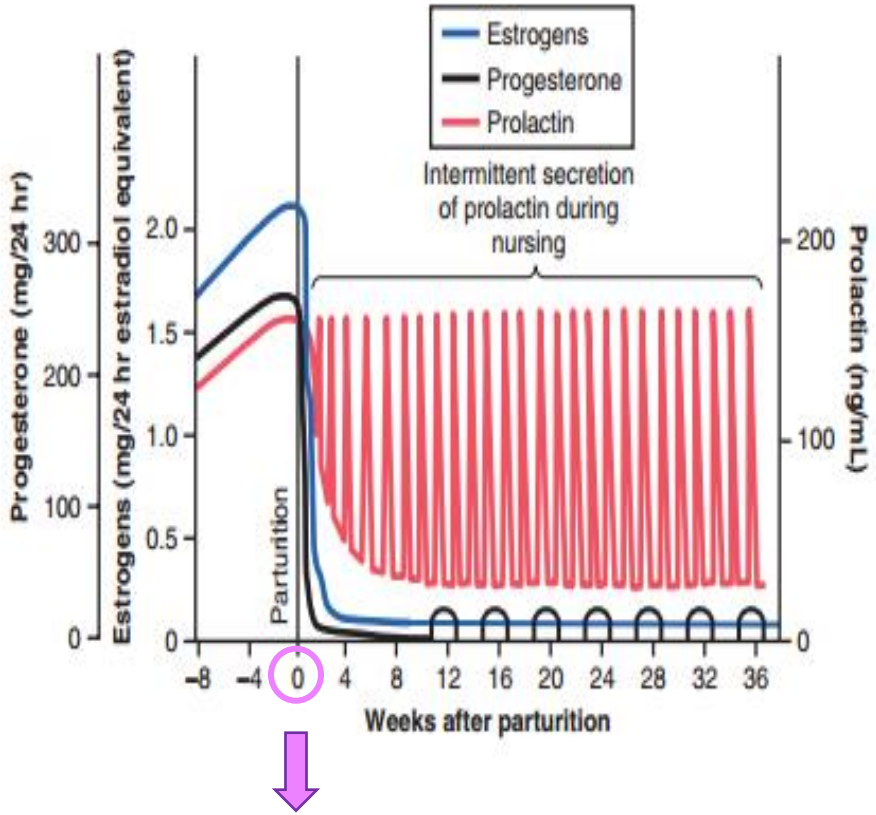
DOCTOR NOTES

Once the ductal system has developed, progesterone—acting synergistically with estrogen, as well as with the other hormones just mentioned—causes additional growth of the breast lobules, with budding of alveoli and development of secretory characteristics in the cells of the alveoli.

Estrogen aids in the development of the breast's ductal system, progesterone prepares the alveoli, and prolactin stimulates milk secretion.

PROLACTIN PROMOTES LACTATION

- Prolactin's blood concentration rises steadily from the fifth week of pregnancy-birth (10 -20X).
- Suppressive effects of estrogen and progesterone, no more than a few milliliters of fluid are secreted until after the baby is born
- Secretions around delivery (about 1-3 days after)→ colostrum; same concentrations of proteins and lactose as milk, but no fat because the baby can't digest fats yet. However, **it's rich in protein and antibodies.**
- During the next 1 to 7 days, milk (containing fat, protein and lactose) is produced instead of colostrum.



- <0 → the last trimester of pregnancy
- 0 → labour
- >0 → postpartum

DOCTOR NOTES

Although **estrogen and progesterone are essential for **physical development** of the breasts during pregnancy, a specific effect of both these hormones is to **inhibit the actual secretion of milk.**

**Secretions in the last few days before and the first few days after parturition is called colostrum; same concentrations of proteins and lactose as milk, but no fat , and its maximum rate 1/100 the subsequent rate of milk production.

** Requires an adequate background secretion of growth hormone, cortisol, parathyroid hormone, and insulin. (amino acids, fatty acids, glucose, and calcium)

During pregnancy

- estrogen's levels are higher than progesterone's
- prolactin is present but in smaller amounts; as its secretion is controlled/inhibited by the higher levels of estrogen and progesterone.

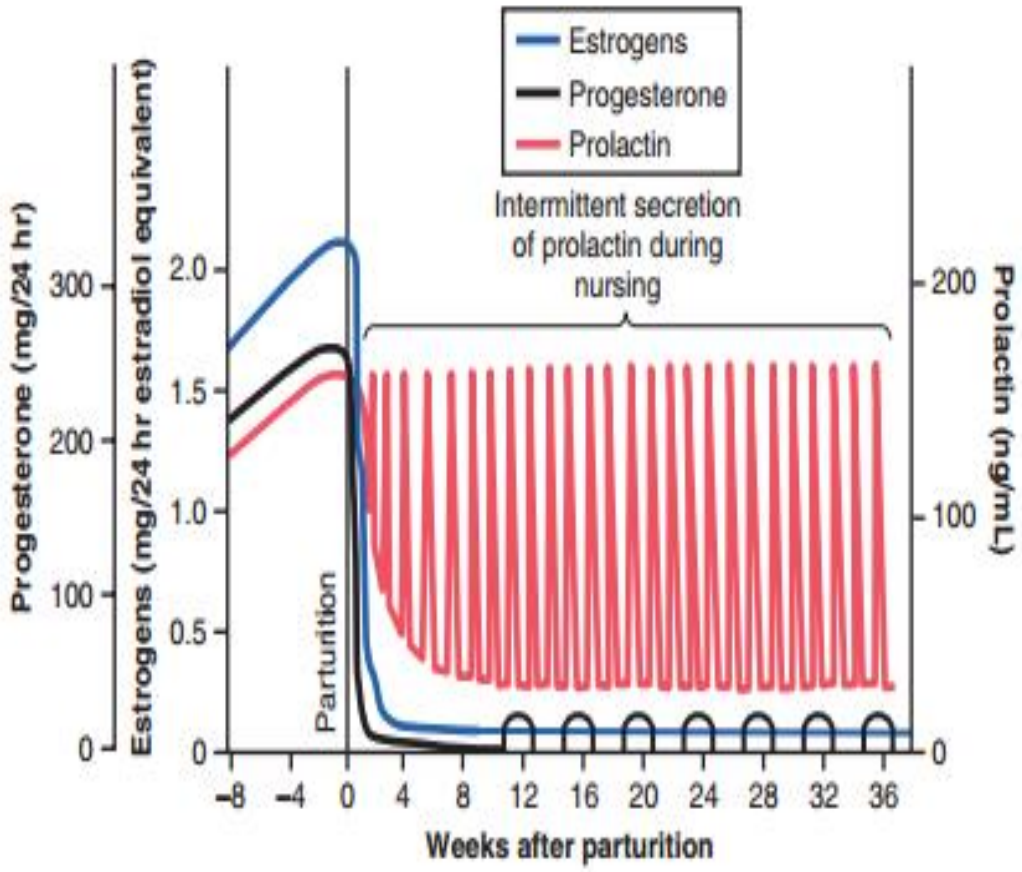
After labour:

- Estrogen and progesterone levels drop
- For prolactin; at first, its levels drop and might reach the same levels before pregnancy. Then, its levels increase in the form "intermittent bursts", each of which lasts about an hour
- The reason why it's secreted in bursts is because its secretion depends on the initiation of breast-feeding. That is, when the mother starts feeding her baby, signals are transmitted to the hypothalamus to release prolcatin-releasing hormone that stimulates the anterior pituitary to secrete prolactin which stimulates the milk-producing cells.

However, prolactin doesn't work alone, oxytocin has to be secreted to act on the myoepithelial cells in order to eject the produced milk into the duct.

PROLACTIN PROMOTES LACTATION

- After the birth of the baby, the basal level of prolactin secretion returns to the nonpregnant level during the next few weeks
- Nervous signals from the nipples to the hypothalamus cause a 10- to 20-fold surge in prolactin secretion that lasts~ 1 hour.
- It keeps the mammary glands secreting milk into the alveoli for the subsequent nursing periods.
- If nursing does not continue, the breasts lose their ability to produce milk within 1 week or so.

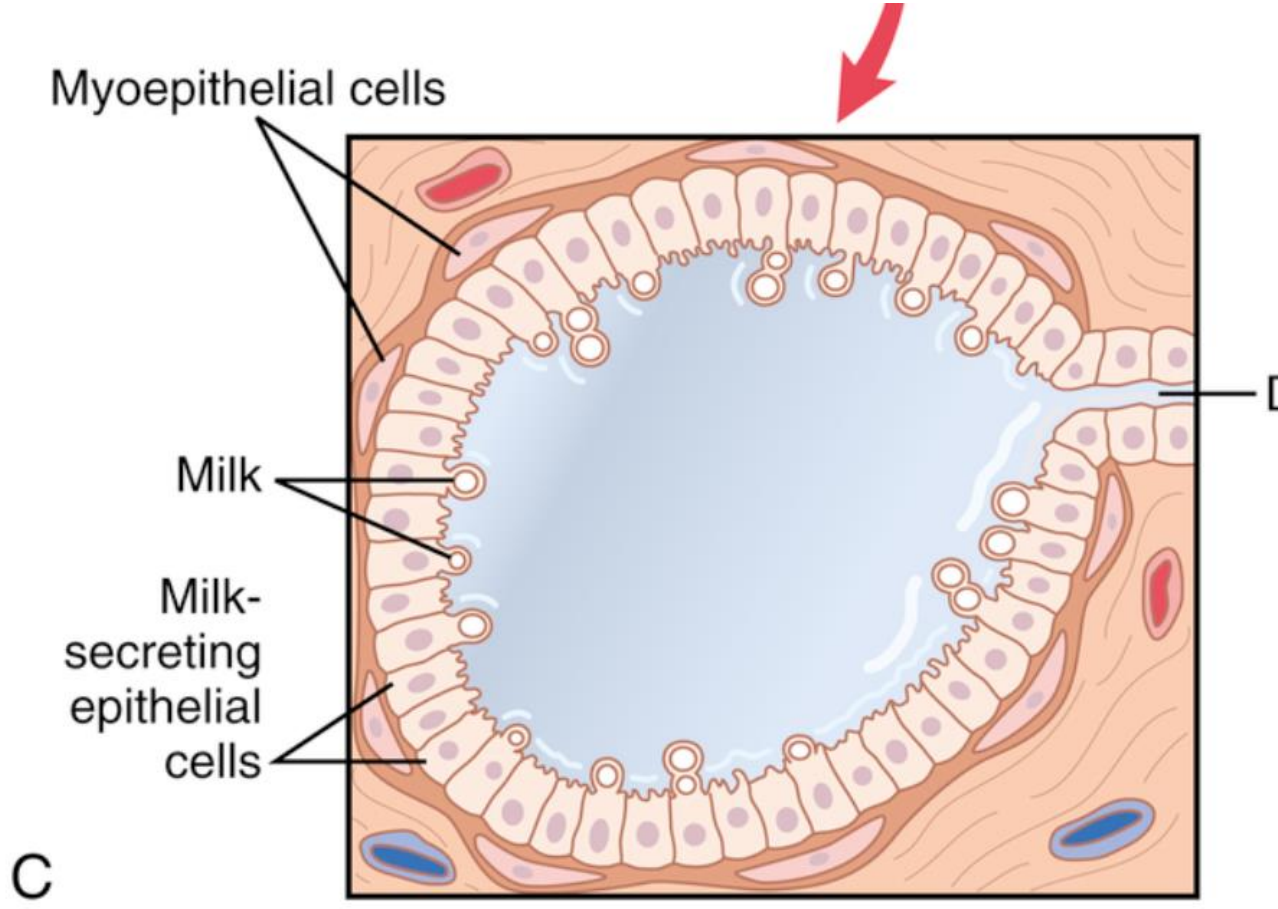


Suppression of the Female Ovarian Cycles in Nursing Mothers for Many Months After Delivery

- **In most nursing mothers, the ovarian cycle (and ovulation) does not resume until a few weeks after cessation of nursing.**
- Nervous signals from the breasts to the hypothalamus —either directly or through prolactin—inhibit secretion of gonadotropin-releasing hormone by the hypothalamus.
- → suppresses FSH&LH → no menstrual cycle (amenorrhea). However, this depends on the frequency of breast-feeding or in other words, how dependent the baby is on his mother's milk. That is, breast-feeding of insufficient frequency **resumes menstrual cycle.**

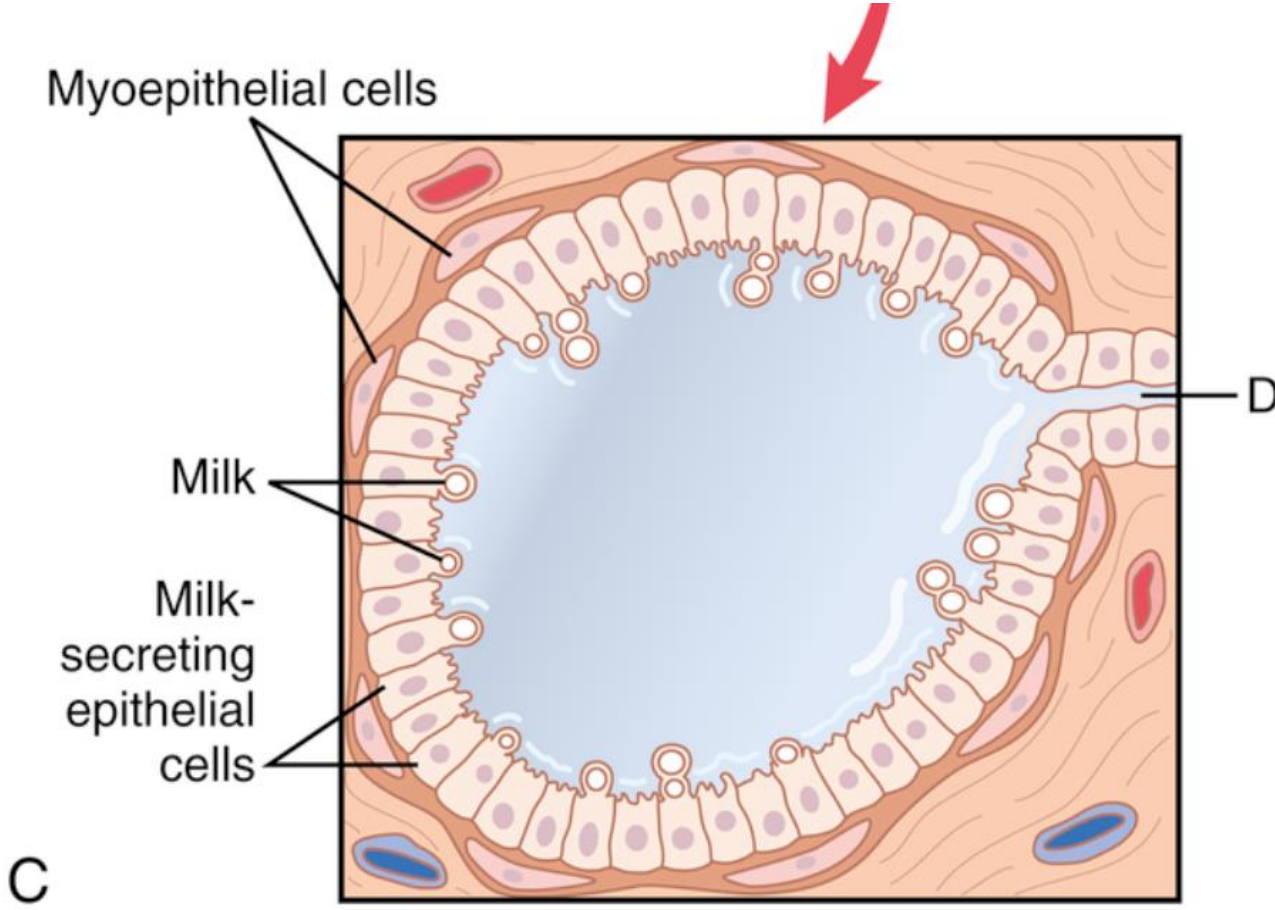
EJECTION (OR "LET-DOWN") PROCESS IN MILK SECRETION—FUNCTION OF OXYTOCIN

- Milk does not flow easily from the alveoli into the ductal system.
- **The whole process** (prolactin, then oxytocin then milk secretion) **depends on the suckling of the baby.**
- When the baby suckles, it receives virtually no milk for the first half minute or so.
- Sensory impulses travels to hypothalamus to promote oxytocin secretion at the same time that they cause prolactin secretion.



EJECTION (OR “LET-DOWN”) PROCESS IN MILK SECRETION—FUNCTION OF OXYTOCIN

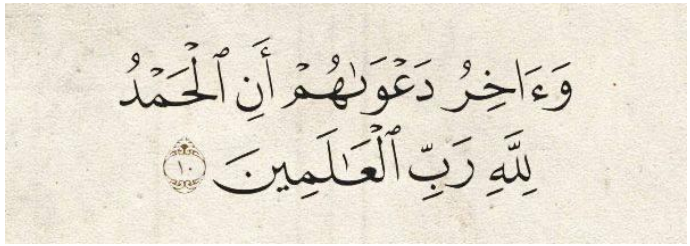
- Oxytocin causes myoepithelial cells to contract, thereby expressing the milk from the alveoli into the ducts.
- Then the baby’s suckling becomes effective in removing the milk.
- Within 30 seconds to 1 minute after a baby begins to suckle, milk begins to flow. This process is called milk ejection or milk letdown.
- Ideally, a mother should aim for a feeding duration of 20 minutes each time.

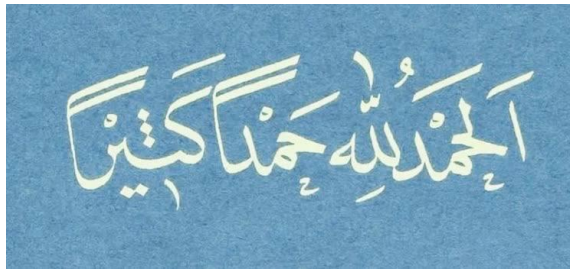


Thank You & Good Luck

Additional sources

1. Book pages
2. Youtube videos
3. Webpages…etc





VERSIONS	SLIDE #	BEFORE CORRECTION	AFTER CORRECTION
V1→ V2			
V2→V3			

امسح الرمز و شاركنا بأفكارك لتحسين أدائنا !!