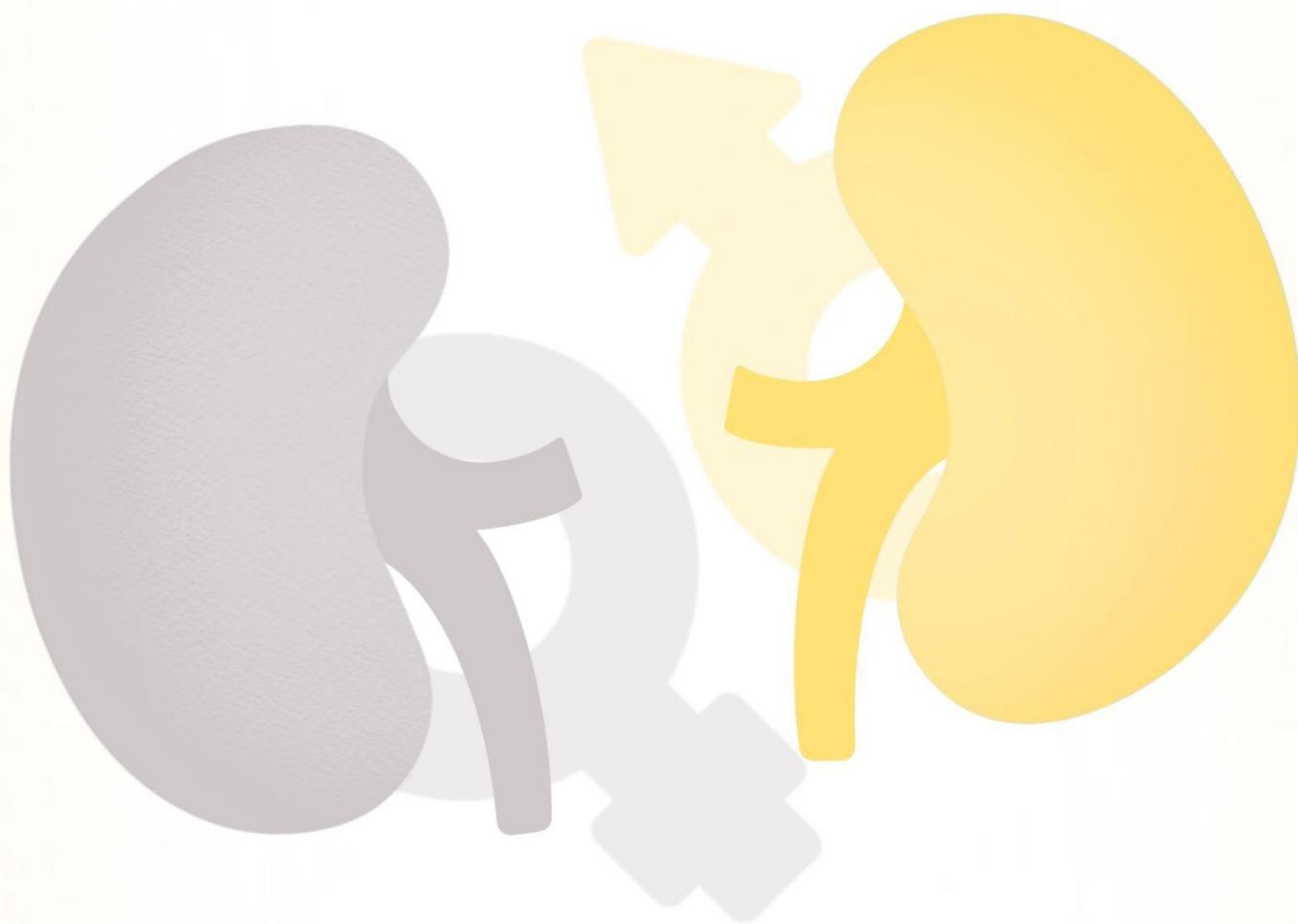


G.U.S.



Physiology

6



Sheet: Labor & lactation

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Parturition

After 40 weeks of pregnancy (from the last menstrual cycle), birth (labor) will start by its own.

- Toward the end of pregnancy, the uterus becomes progressively more excitable, until finally it develops such strong rhythmical contractions that can expel the baby (parturition).

The exact cause of this increased activity is not known, but at least two major categories of effects lead up to the intense contractions responsible for parturition:

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

(2) **Progressive mechanical changes** take place by the end of the pregnancy period.

Hormonal Factors That Increase Uterine Contractility

1-Increased Ratio of Estrogens to Progesterone.

(Estrogens levels are a little more than progesterone that will induce contractility).

- Progesterone inhibits uterine contractility, however, estrogens increase the contractility, partly because estrogens increase the number of gap junctions between the adjacent uterine smooth muscle cells -> that will increase the transduction between them increasing their contractions.

- From the 7th month onward, estrogen secretion continues to increase while progesterone secretion remains constant or perhaps decreases.

2-Oxytocin Causes Contraction of the Uterus

Oxytocin, a polypeptide secreted by the neurohypophysis, specifically causes uterine contraction.

There are four reasons to believe that oxytocin might be important in increasing the contractility of the uterus near term (when the 40 weeks of the pregnancy finish):

1. The uterine muscle increases its oxytocin receptors last few months of pregnancy.
2. The rate of oxytocin secretion by the neurohypophysis is increased at the time of labor.
3. Although hypophysectomized animals (in experiments) can still deliver at term, labor is prolonged.
4. Experiments in animals indicate that irritation of cervix causes a neurogenic reflex through the paraventricular and supraoptic nuclei of the hypothalamus that causes secretion of oxytocin.

3-Effect of Fetal Hormones on the Uterus.

The fetus' pituitary gland secretes increasing quantities of oxytocin,

- Fetus' adrenal glands secrete large quantities of cortisol (corticosteroids), possible uterine stimulant.
- Fetal membranes release prostaglandins in high concentration at the time of labor, which can increase the intensity of uterine contraction (can be used as a medication to induce labor).

MECHANICAL FACTORS THAT INCREASE UTERINE CONTRACTILITY

1-Stretch of the Uterine Musculature.

Simply stretching smooth muscle organs usually increases their contractility. Further, intermittent stretch, which occurs repeatedly in the uterus because of fetal movements, can also elicit smooth muscle contraction at the last weeks of pregnancy.

*Twins; on average, 19 days earlier than a single child-> due to further stretch of the uterine musculature.

2-Stretch or Irritation of the Cervix

Ex; obstetricians frequently induce labor (if it's not induced by its own) by rupturing the fetal membrane so the head of the baby stretches the cervix, then the labor will start shortly or in hours.

*The stretch will take place due to neural reflexes to the body of the uterus **or** could be only myogenic transmission of stretch from the cervix to the uterus. (Unknown mechanism)

Video on labor: <https://www.youtube.com/watch?v=jFdXx35VR-o>

LABOR, A POSITIVE FEEDBACK MECHANISM FOR ITS INITIATION

- During most of the pregnancy months, the uterus undergoes periodic episodes of weak and slow rhythmical contractions called **Braxton Hicks contractions**.

- They become progressively stronger, constant, and frequent by the end of pregnancy: then start stretching the cervix and later force the baby through the birth canal, causing parturition. Now are called **labor contractions**.

*The positive feedback theory suggests that: stretching of the cervix by the fetus's head finally becomes great enough to elicit a strong reflex (a positive loop), through:

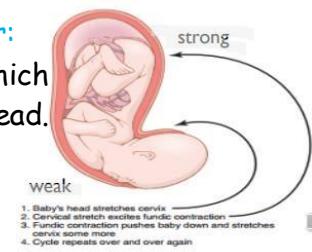
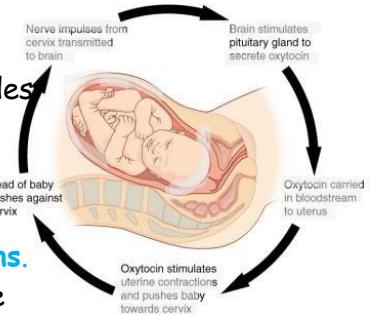
- 1- Automatic response for uterus smooth muscles
- 2- Initiating a nerve impulse transmitted to the brain, which stimulates the posterior pituitary gland to secrete oxytocin that is carried through bloodstream into uterus to stimulate uterine contractions and pushes the baby towards cervix.
- Increase in contractility of the uterine body pushes the baby forward, which stretches the cervix more and initiates more positive feedback to the uterine body. (process repeats until the baby is expelled).
- Labor contractions obey all positive feedback principles which makes it the most accepted theory.

- **Two known types of positive feedback increase uterine contractions during labor:**

(1) Stretching of the cervix causes the entire body of the uterus to contract, which stretches the cervix even more because of the downward thrust of the baby's head. Cervix has weaker contraction than the body to allow more space for the baby to be expelled.

- Toward the end of pregnancy, the cervix becomes soft, which allows it to stretch when labor contractions begin in the uterus.

(2) Cervical stretching also causes the pituitary gland to secrete oxytocin.



LABOR, ABDOMINAL MUSCLE'S ROLE.

- Pain signals originate both from the uterus and from the birth canal, in addition to causing suffering, they elicit neurogenic reflexes in the spinal cord to the abdominal muscles, causing them to intensely contract, which add up to uterine contractions toward expulsion of the baby.

LABOR MECHANICS

- Early at labor, contractions occur once every 30 min. Rule of 4-1-2 → uterine contractions are 4 min apart last for 1 min that occur in rhythm for at least 2 h. = labor and should go to hospital.

- As labor progresses, the contractions become stronger, once every 1- 3 min, the intensity increases greatly, with only a short period of relaxation between contractions.

- Combined contractions of the uterine and abdominal musculature during delivery cause a downward force of contraction on the fetus of about 25 pounds during each strong contraction.

** intermittently not strong contractions because strong ones could stop blood flow through the placenta causing death of the fetus if they were continuous due to hypoxia.

- when uterine stimulants are used, such as oxytocin, (if it is at high level, or continues administration) can cause uterine spasm can lead to death of the fetus.

- In >95 % of births, the head is the first part of the baby to be expelled, and in remaining instances, mostly the buttocks or the feet are presented first (**breech presentation**). And it is very hard to have a normal labor with this position.

Labor stages: <https://www.youtube.com/watch?v=iaVuIaVpx5Q>

****The first stage:** is a period of progressive cervical dilation, until the cervical opening is as large as the head of the fetus (complete effacement). lasts for 8-24 h in the 1st pregnancy, few min after many pregnancies.

- The fetal membranes will rupture, and the amniotic fluid is lost suddenly through the vagina.

***The second stage:** The head of the fetus moves rapidly through the birth canal, and with additional force from above, it continues to wedge its way through the canal until delivery occurs. It may last from 1 min after many pregnancies to 30 min.

LABOR, SEPARATION AND DELIVERY OF THE PLACENTA

- For (10-45) minutes after birth, the uterus continues to contract to a smaller and smaller size, which causes a shearing effect between uterus walls and the placenta, thus separating the placenta from its implantation site. Separation of the placenta opens the placental sinuses and causes bleeding 350 ml, this bleeding doesn't last for long time, **because:**

1- The smooth muscle fibers of the uterine musculature are arranged in figures of eight around the blood vessels through the uterine wall so when they contract, they block the vessel.

2- It is believed that vasoconstrictor prostaglandins formed at the placental separation site cause additional blood vessel spasm.

LABOR PAIN

- In early labor, pain is due to hypoxia of uterine muscles due to compression of the blood vessels in the uterus. Via visceral sensory hypogastric nerves (carry visceral sensory fibers from the uterus).

- During the **second stage of labor**, much more severe pain is caused by cervical stretching, perineal stretching, and stretching or tearing of structures in the vaginal canal itself. This pain is conducted to the mother's spinal cord and brain by somatic nerves instead of **visceral sensory nerves**.

AFTER LABOR: postpartum bleeding.

- During early involution of the uterus, the placental site on the endometrial surface autolyzes, causing a vaginal discharge (**lochia**) which is first bloody, then serous in nature and continues for a total of about **10 days up to 40 days**.

- After this time, the endometrial surface becomes re-epithelialized to begin a new female cycle.

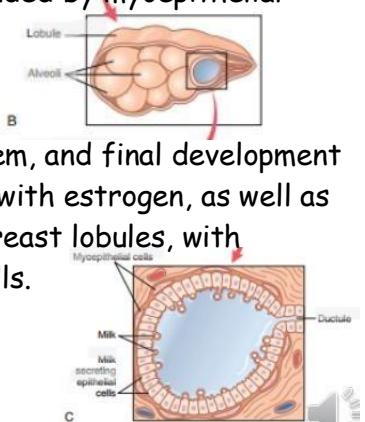
LACTATION

A very important process that enables mother to feed her baby during His/her 4-6 months of life. There are many hormones required for the lactation process including Estrogens, Progesterone, Prolactin, Adrenal glucocorticoids, Insulin and Growth hormone which are needed for protein metabolism.

- The breast structures that enable lactation are the lobes that contain lobules, and these lobules have alveoli which are modified milk-producing sweat glands that are surrounded by myoepithelial cells that expel the milk in a ductal system (**lactiferous duct**) which carry the milk out of the gland.

- Estrogens Stimulate Growth of the Ductal System of the Breasts.

- Progesterone is required for full development of the Lobule-Alveolar System, and final development of the breasts into milk-secreting organs. Progesterone acts synergistically with estrogen, as well as with the other hormones just mentioned, causing additional growth of the breast lobules, with budding of alveoli and development of secretory characteristics in alveoli cells.



PROLACTIN

 is the primary hormone that PROMOTES LACTATION

- Secreted by the mother's anterior pituitary gland.

- Its concentration in her blood rises steadily from the 5th week of pregnancy until birth, 10- 20 times as much as the normal nonpregnant level. Its increase in the last trimester goes parallel with

the increasing estrogen and progesterone levels, and due to their suppressive effects, no more than few ml of fluid are secreted until after the baby is born.

- In addition, the placenta secretes large quantities of human chorionic somatomammotropin, which probably has lactogenic properties, supporting the prolactin.

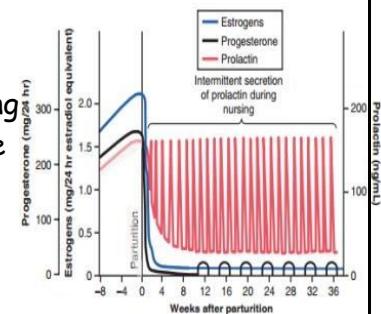
- **Colostrum:** Secretions in the last few days before and the first few days after parturition.

It has the same concentrations of proteins and lactose as milk, but no fat, and its maximum rate of secretion is 1/100 the subsequent rate of milk production. Also, it is rich with immunoglobulins.

- Sudden loss of both estrogen and progesterone secretions from the placenta at birth allows the lactogenic effect of prolactin to assume its natural milk promoting role, and 1 to 7 days after delivery, milk is produced instead of colostrum.

- Normal lactation process requires an adequate background secretion of growth hormone, cortisol, parathyroid hormone, and insulin to provide amino acids, fatty acids, glucose, and calcium.

- The basal level of prolactin secretion returns to the nonpregnant level during the next few weeks after delivery, but with some fluctuations because of the **Nervous signals** sent from the nipples to the hypothalamus, causing a (10-20) fold surge in prolactin secretion that lasts~ 1 h, whenever the baby suckles the breast, to keep the mammary glands secreting milk into the alveoli for the subsequent nursing periods.



PROLACTIN INHIBITORY HORMONE-HYPOTHALAMUS

- As we know, hypothalamus secretions induce the secretion of the pituitary gland hormones but here the opposite will happen.

- The Hypothalamus secretes Prolactin Inhibitory Hormone, and by this it controls prolactin secretion.

- Damage to the hypothalamus or blockage of the hypothalamic-hypophysial portal system often increases prolactin secretion while it depresses secretion of the other anterior pituitary hormones. Because: Prolactin is inhibited by a factor transported through the hypothalamic-hypophysial portal system to the anterior pituitary gland.

- This factor is the catecholamine **Dopamine**, which is secreted by the arcuate nuclei of hypothalamus and can decrease prolactin secretion as much as 10-fold.

****The hypothalamus controls prolactin secretion by inhibiting prolactin production****

SUPPRESSION OF THE FEMALE OVARIAN CYCLES IN NURSING

- In most nursing mothers, the ovarian cycle (and ovulation) will be suppressed and does not resume until a few weeks after cessation of nursing, or the nursing become less regular (the baby starts to eat solid food).

- The same nervous signals from the breasts to the hypothalamus that cause prolactin secretion during suckling—either because of the nervous signals or because of a subsequent effect of increased prolactin— inhibit secretion of gonadotropin-releasing hormone by the hypothalamus.

- This inhibition, in turn, suppresses formation of the pituitary gonadotrophic hormones—LH & FSH.

- However, after several months of lactation, in some mothers (especially those who nurse their babies only some of the time), the pituitary begins to secrete sufficient gonadotrophic hormones to reinstate the monthly female sexual cycle

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

- Milk does not flow easily just by prolactin from the alveoli into the ductal system, it must be ejected from the alveoli into the ducts before the baby can obtain it. This ejection is caused by a combined neurogenic and hormonal reflex that involves the posterior pituitary hormone **Oxytocin**.
- When the baby suckles, it receives virtually no milk for the first half minute or so. Sensory impulses must first be transmitted through somatic nerves from the nipples to the mother's spinal cord and then to her hypothalamus where they cause nerve signals that promote oxytocin secretion at the same time that cause prolactin secretion.
- The oxytocin is carried in the blood to the breasts where it causes myoepithelial cells (which surround the outer walls of the alveoli) to contract, thereby expressing the milk from the alveoli into the ducts at a pressure of +10 to 20 mm Hg.

So baby's suckling becomes effective in removing the milk. Thus, within 30 seconds to 1 minute after a baby begins to suckle, milk begins to flow.

MILK COMPOSITION

- 1.5 L of milk may be formed each day (more if the mother has twins).
- High energy is drained from the mother: approximately 650-750 kcal/L are contained in breast milk, and large metabolic substrates are also lost from the mother.
- Diet of mom should contain milk, vitamin D, & calcium to supply needed calcium and phosphate to the baby.
If the diet was lacking **Calcium or Vit D**, the parathyroid glands enlarge, and the bones become decalcified.
- Decalcification is usually not a big problem during pregnancy, but more important during lactation.
- Multiple types of Antibodies and other anti-infectious agents are secreted in milk along with the nutrients.
- WBCs secreted (neutrophils and macrophage) can be lethal to bacteria that could cause deadly infections such as (E-coli), which can lead to diarrhea.

Constituent	Human Milk (%)
Water	88.5
Fat	3.3
Lactose	6.8
Casein	0.9
Lactalbumin and other proteins	0.4
Ash	0.2
	calcium phosphate

Good luck