

# Physiology of Labor

# Objectives:

- ❖ Define labor/labour (parturition).
  - ❖ Recognize the factors triggering the onset of labor.
  - ❖ Describe the hormonal changes that occur before and during labor.
  - ❖ Describe the phases of uterine activity during pregnancy and labor.
  - ❖ Know the clinical stages of labor..
- 

## Color index:

- ❖ **Important.**
- ❖ **Girls slide only.**
- ❖ **Boys slide only.**
- ❖ **Dr's note.**
- ❖ **Extra information.**



**Editing File**

# Parturition\* / Labor\*

## Definition:

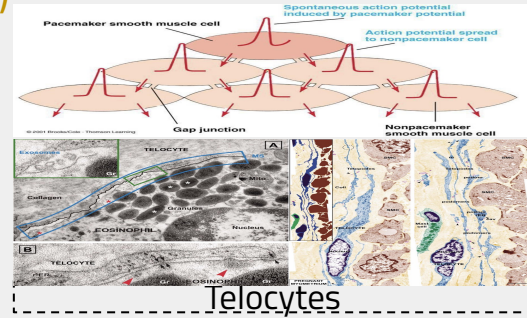
**Labor/Parturition:** Uterine contractions that lead to expulsion of the **fetoplacental unit/ fetus** to the extrauterine environment.

- Towards the end of pregnancy the uterus becomes progressively more excitable and develops strong rhythmic contractions that lead to the expulsion of the fetus **and placenta**.

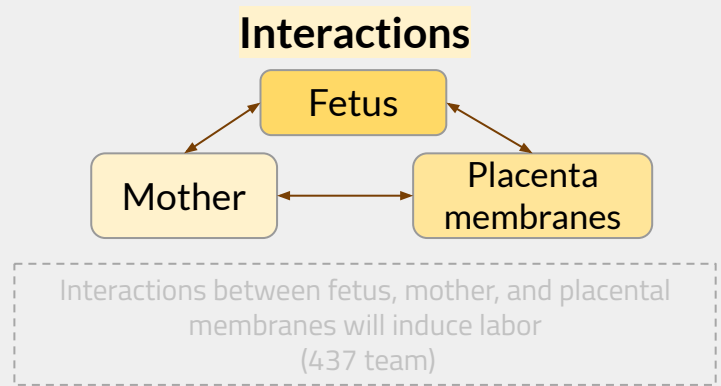
Does the non-pregnant uterus contract???

**Yes, during menstrual cycle (cramps). Also during sexual intercourse helping sperm suction and transport (previous lecture)**

- Uterus is spontaneously active.
- Spontaneous depolarization of pacemaker cells (telocytes<sup>(1)</sup>).
- GAP junctions spread depolarization<sup>(2)</sup>.
- Exact trigger of labor is unknown.



Normal Pregnancy:	During Labor:
Uterine quiescence	Coordinated uterine activity
Immature fetus	Maturation of the fetus
Closed cervix	Progressive cervical dilation



- **During labor two types of changes occur:**

### 1- Hormonal Changes

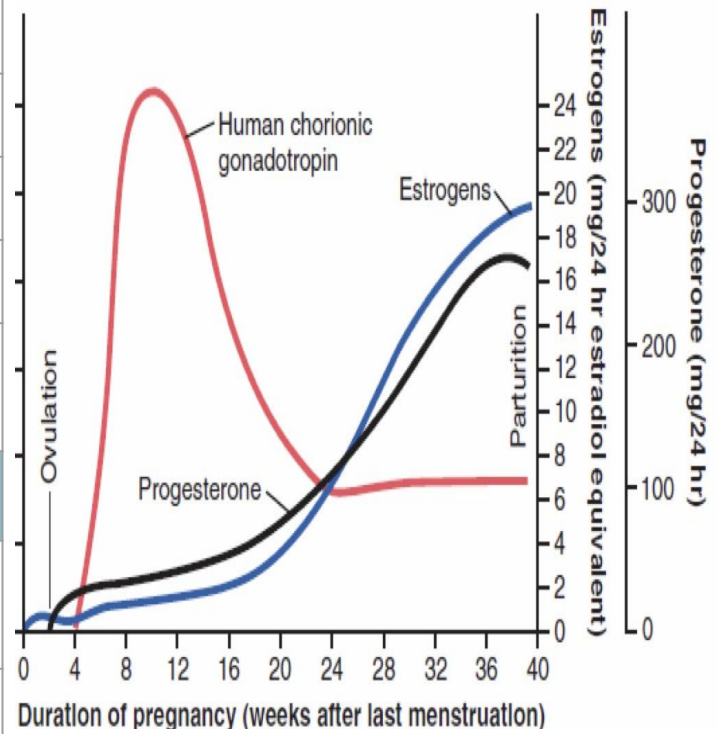
- Estrogen
- Progesterone
- Oxytocin
- Prostaglandins

### 2-Mechanical Changes

- Stretch of the uterine muscle
- Stretch of the cervix

## 1- Hormonal Changes

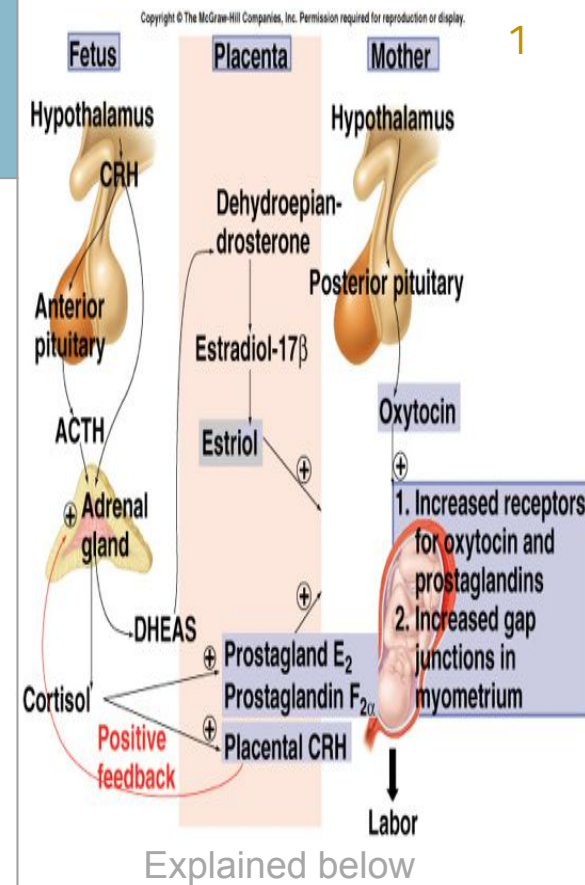
Progesterone	Estrogen <sup>(3)</sup>
<b>Inhibit uterine contractility</b>	<b>Stimulate uterine contractility</b>
↓ GAP junctions	↑ GAP junctions
↓ Oxytocin receptors	↑ Oxytocin receptors
↓ Prostaglandins F	↑ Prostaglandins F
↑ Prostaglandins E and I	↓ Prostaglandins E and I
↑ Negativity of the resting membrane potential	-
<b>From the 7th month till term</b>	
Secretion remains constant or <b>decreases slightly</b>	Secretion increases continuously
Estrogen/Progesterone ratio increases <b>sufficiently towards the end of pregnancy to be at least partly responsible for the increased contractility of the uterus</b>	



1) Telocytes are elongated cells with elongated processes (telopodes). It spreads between the muscle cells and cause spread of the activity  
 2) If it the depolarization starts in one cell it will spread to other cells causing a synchronized contraction  
 3) Upper hand for estrogen, estrogen will cause activation of the uterus

# 1- Hormonal Changes cont...

<b>Oxytocin</b> <i>(increases uterine contractions most important one)</i>	<b>Prostaglandins</b> <i>(increases cervical dilation and effacement)</i>
<p>Dramatic ↑ of oxytocin receptors (200) folds</p> <ul style="list-style-type: none"> <li>Gradual transition from passive relaxed to active excitatory muscle (↑ responsiveness).</li> <li>Increase in oxytocin secretion at labor <b>by posterior pituitary gland</b>.</li> <li>Oxytocin increases uterine contraction by:               <ol style="list-style-type: none"> <li>Directly on its receptors.</li> <li>Indirectly by stimulating prostaglandin (PGF2α) production.</li> </ol> </li> </ul>	<ul style="list-style-type: none"> <li>Central role in initiation and progression of human labor (<b>Not only initiation</b>).</li> <li>Locally produced (intrauterine), paracrine.</li> <li>Oxytocin and cytokines stimulate its production.</li> <li>Prostaglandin stimulate uterine contractions by:               <ol style="list-style-type: none"> <li>Direct effect:                   <ol style="list-style-type: none"> <li>Through their own receptors.</li> <li>Upregulation of myometrial GAP junctions (<b>Similar to estrogen</b>).</li> </ol> </li> <li>Indirect effect:                   <ul style="list-style-type: none"> <li>Upregulation of oxytocin receptors.</li> </ul> </li> </ol> </li> </ul> <p><small>كأنه يزود نفسه Because oxytocin increases PGs production, when PGs are produced they will upregulate oxytocin receptor. (Positive feedback)</small></p>



## 2- Mechanical Changes

Stretch of the uterine muscle	Stretch of the cervix
<ul style="list-style-type: none"> <li>Increase in contractility</li> </ul> <p>Examples of mechanical stretch eliciting uterine contractions:</p> <ul style="list-style-type: none"> <li><b>Fetal movements.</b> Because it will stretch the uterus and lead to contractions. So, if a woman is pregnant with twins or more we give her progesterone to stably her pregnancy and prevent early contractions.</li> <li>Multiple pregnancy/size of uterus (<b>Twins, triplets</b>)</li> </ul>	<ul style="list-style-type: none"> <li>Stretch of the cervix → Increase contractility (reflex) (<b>Positive feedback mechanism</b>)</li> </ul> <p>Examples of mechanical changes stretching or irritating the uterine cervix:</p> <ul style="list-style-type: none"> <li><b>Membrane sweeping and rupture</b></li> <li><b>Fetal head.</b> (the head of the baby stretches the cervix more forcefully than usual or irritates it in other ways).</li> </ul>

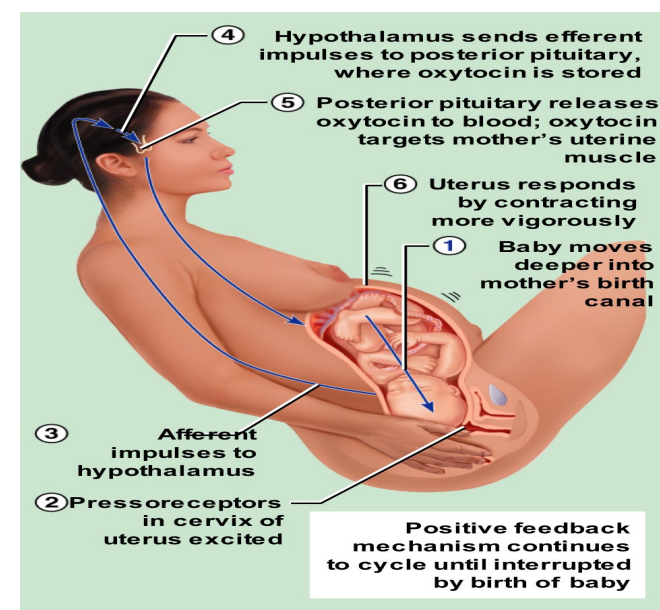
## Onset of Labor

### During Pregnancy:

- periodic episodes of weak and slow rhythmic uterine contractions (braxton hicks) 2nd trimester.

### Towards the end of Pregnancy

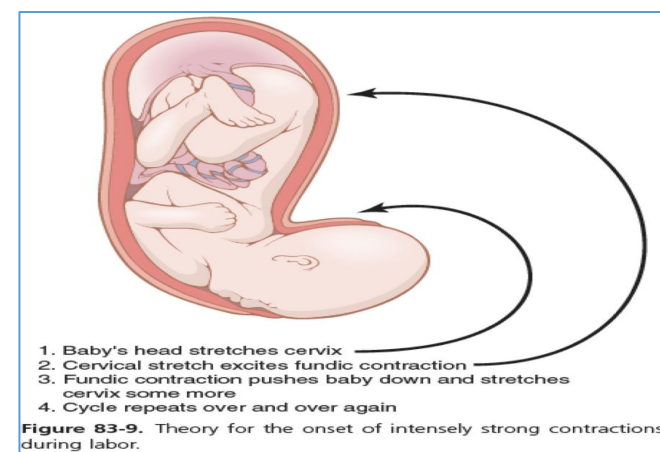
- Uterine contractions become progressively stronger.
- Uterine contractions change suddenly, within hours, to become strong contractions leading to cervical stretching and force the baby through the birth canal.



## Positive Feedback Mechanisms

### Labor contractions obey all the principles of Positive Feedback:

- Stretching of the cervix causes the entire body of the uterus to contract. (**Nervous feedback**)
- Stretching of the cervix also causes pituitary gland to secrete oxytocin. (**Hormonal feedback**)



1) When the fetus reaches maturity, its hypothalamus will start releasing CRH in high level which will stimulate the anterior pituitary to release ACTH that acts on the cortex of the adrenal gland which will release DHEAS and cortisol. DHEAS will be taken up by the placenta and converted to estradiol (estrogen). Cortisol will also be taken up by the placenta and it will stimulate PGs production and placental CRH production, CRH will go back to the fetal blood to stimulate release cortisol (positive feedback). The mother's hypothalamus will release oxytocin from the posterior pituitary (the posterior pituitary becomes bigger and steals the supply from anterior pituitary, if a pregnant women loses blood during childbirth she is at a risk of ischemia to AP "Sheehan syndrome"). The end result: Increased oxytocin and PGs receptors. Increased gap junctions.

❖ When the duration of pregnancy exceeds 40 weeks, membrane sweeping is done. Membrane sweeping is a procedure in which the membrane is separated from the uterine wall to induce PGs release and contraction of the uterus

# Phases of Parturition

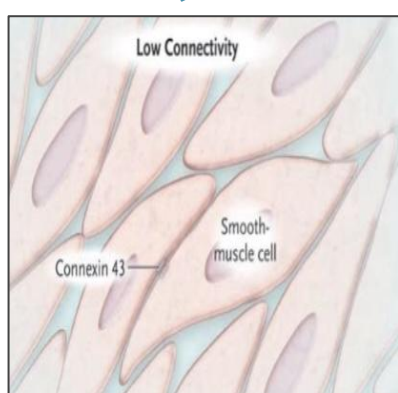
## 1 Phase 0 (Pregnancy) (Quiescence)

Most of pregnancy is at this phase

- ❖ Occurs during early pregnancy. The uterus is relaxed (quiescent).
- ❖ Increase in cAMP level. Causes relaxation when it accumulates
- ❖ It has been hypothesized that the higher progesterone levels increase in production of:-

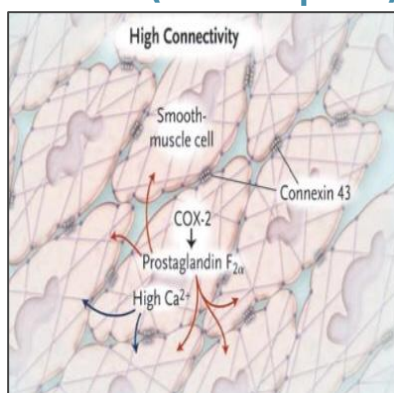
**Prostacyclin (PGI<sub>2</sub>), Nitric oxide (NO), and Parathyroid hormone-related protein (PTHrP)** which can all cause uterine relaxation.

### Phase0: Quiescence



### Phase3 (Involution)

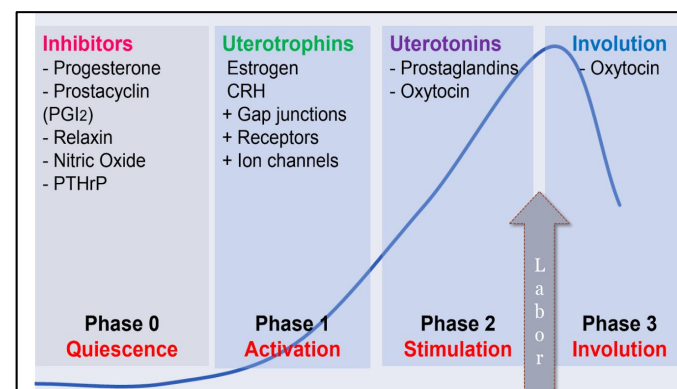
### Phase1: (Uterotrophins)



### Phase2 (Uterotonins)

## 2 Phase 1 (Activation)

- ❖ Occurs in **third trimester**.
- ❖ Promote a switch from quiescent to active uterus.
- ❖ Increase excitability & responsiveness to stimulators by:-
  - Increasing expression of gap junctions.
  - Increasing G protein-coupled receptors (**Oxytocin receptors & PGF2 alpha receptors**).



CRH: Increases cortisol production in both the fetus and mother and results in inhibition of progesterone receptors (shifting the balance towards estrogen, and thereby uterine contraction), CRH receptors are expressed in the uterus, they are postulated to be responsible for PGs production.  
Uterotrophins: Enhance the excitatory functions of the uterus.  
Uterotonins: Inducers of uterine contraction.

Phases are on the molecular level, whereas stages are seen and felt

## 3 Phase 2 (Stimulation)

Pregnancy = 40 weeks. Delivery = 37th week

- ❖ Occurs in the **last 2-3 gestational weeks**.
- ❖ Increase in synthesis of uterotonins (cytokines, prostaglandins and oxytocin).
- ❖ Includes 2 stages:-
  - Stage one.
  - Stage two.

## 4 Phase 3 (Uterine Involution)

- ❖ Occurs **4-5 weeks after delivery**. النفاس
- ❖ Pulsatile release of oxytocin.
- ❖ Delivery of the placenta and involution of the uterus.
- ❖ Lactation helps in complete involution. Increased oxytocin during lactation
- ❖ Includes stage 3.

## Mechanism of Parturition

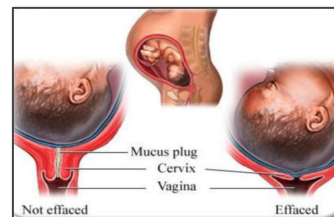
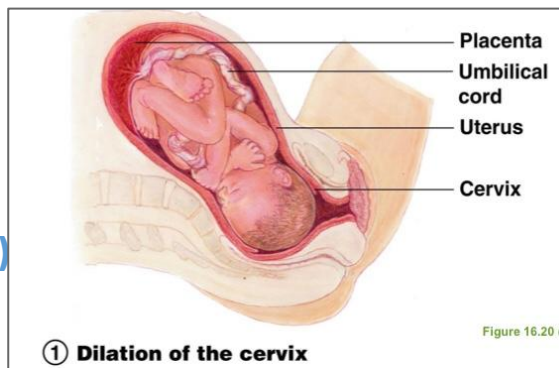
- ✓ Contractions start at the fundus and spread to the lower segment. (Baby won't move and will get squeezed if both lower and upper segments are contracted)
- ✓ The intensity of contractions is strong at the fundus but weak at the lower segment.
- ✓ In early stages: **1 contraction/30 min**, As labor progresses: **1 contraction/1-3 min**.
- ✓ Abdominal wall muscles contract.
- ✓ Rhythmic contractions allow blood flow.

# Stages of Labor

## Stage 1 (Dilation)

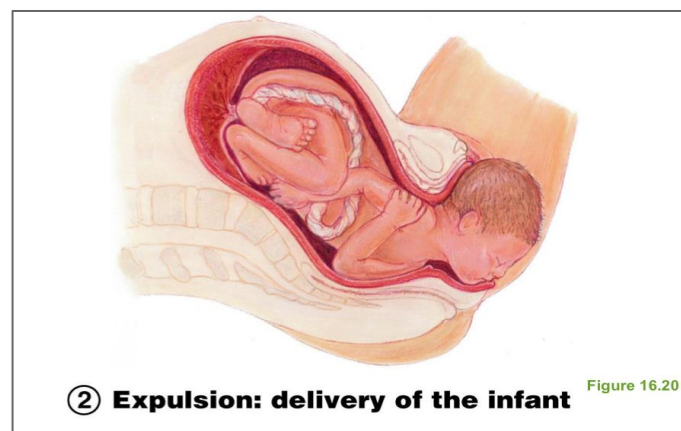
- ❖ It's the longest stage of labor.
  - 6-12 hours.
  - 6-20 hours (primipara), 6-14 hours (multipara)
- ❖ **Cervix becomes dilated**, full dilation is **10 cm**.
- ❖ Uterine contractions begin and increase.
- ❖ **Cervix softens and effaces** (thins)
- ❖ **The amnion ruptures "breaking the water"**.

**IIMP clinical note** do not deliver oxytocin when the cervix isn't dilated it will cause uterine rupture



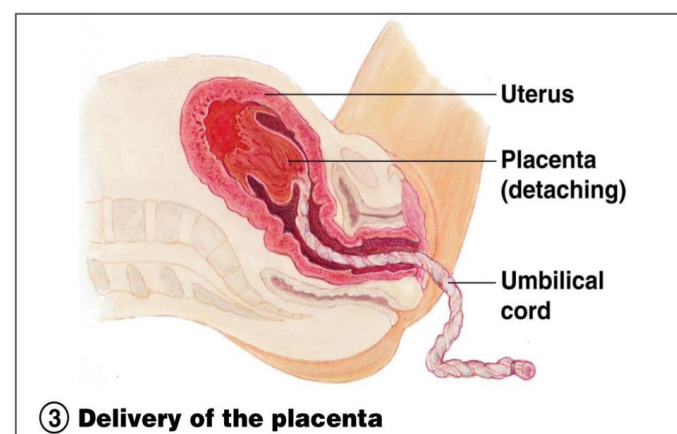
## Stage 2 (Expulsion/Descent of the fetus)

- ❖ Duration: can last as long as **2 hours in a multipara** and **3 hrs in a primipara**, but typically is 50 minutes in the first birth and 20 minutes in subsequent births.
- ❖ Begins with complete cervical dilation and ends with **delivery of the fetus**.
- ❖ It includes:
  - The passive phase (passive descent of the fetal head)
  - The active phase (expulsive phase, bearing down or pushing by the mother)
- ❖ Infant passes through the cervix and vagina.
- ❖ Normal delivery is head first (vertex position).
- ❖ Breech presentation is buttocks-first.



## Stage 3 (Placental Stage)

- ❖ Delivery of the placenta, usually accomplished within 15-30 minutes after birth of infant.
- ❖ Begins with delivery of the fetus and ends with **expulsion of the placenta**.
- ❖ Afterbirth—placenta attached to the fetal membranes are delivered.
- ❖ All placental fragments should be removed to avoid postpartum bleeding.

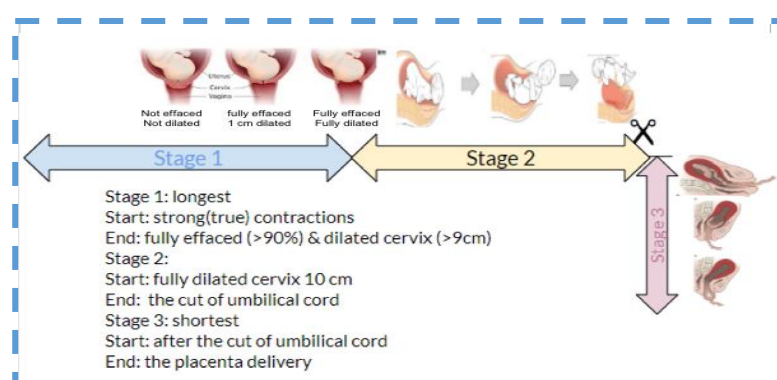


### important

Stage 1- Cervical Dilation

Stage 2- Expulsion of the fetus

Stage 3- Delivery of the placenta



# MCQ & SAQ:

**Q1: Which of the following is False regarding Progesterone?**

- A. Increase negativity of the resting membrane potential
- B. Secretion is constant from the 7th month till term
- C. Decrease oxytocin receptors
- D. increase GAP junctions

**Q3: During labor, oxytocin increases uterine contractions by stimulating the formation of?**

- A. PGE2
- B. PGI2
- C. PGF2 $\alpha$
- D. Nitric Oxide

**Q5: at which stage the amnion ruptures?**

- A. stage 1
- B. stage 2
- C. stage 3
- D. stage 0

**Q2: Which of the following hormones inhibit uterine contractility?**

- A. Oxytocin
- B. Progesterone
- C. Prostaglandins
- D. Estrogen

**Q4: which of the following substances causes uterine relaxation?**

- A. estrogen
- B. PGE2
- C. PTHrP
- D. oxytocin

**Q6: phase 2 of parturition occur at?**

- A. third trimester
- B. early 2-3 gestational weeks
- C. late 2-3 gestational weeks
- D. A&B

6: C  
5: A  
4: C  
3: C  
2: B  
1: D  
key:  
answer

**1- Explain how positive feedback works in labor contractions.**

**2- How does Prostaglandin stimulate uterine contraction?**

**3- what can be a cause of postpartum bleeding?**

**4- list the phases of parturition?**

**A1:** 1-Stretching of the cervix causes the entire body of the uterus to contract.

2- stretching of the cervix also causes the pituitary gland to secrete oxytocin.

**A2:** Direct effect: 1- Through their own receptors. 2- Upregulation of myometrial GAP junction.  
Indirect effect: Upregulation of oxytocin receptors.

**A3:** incomplete removal of placental fragments

**A4:** phase 0: quiescence, phase 1: activation, phase 2: stimulation, phase 3: uterine involution

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- Yara Alomar

