Physiology of Labor

GUYTON & HALL, Chapter 82

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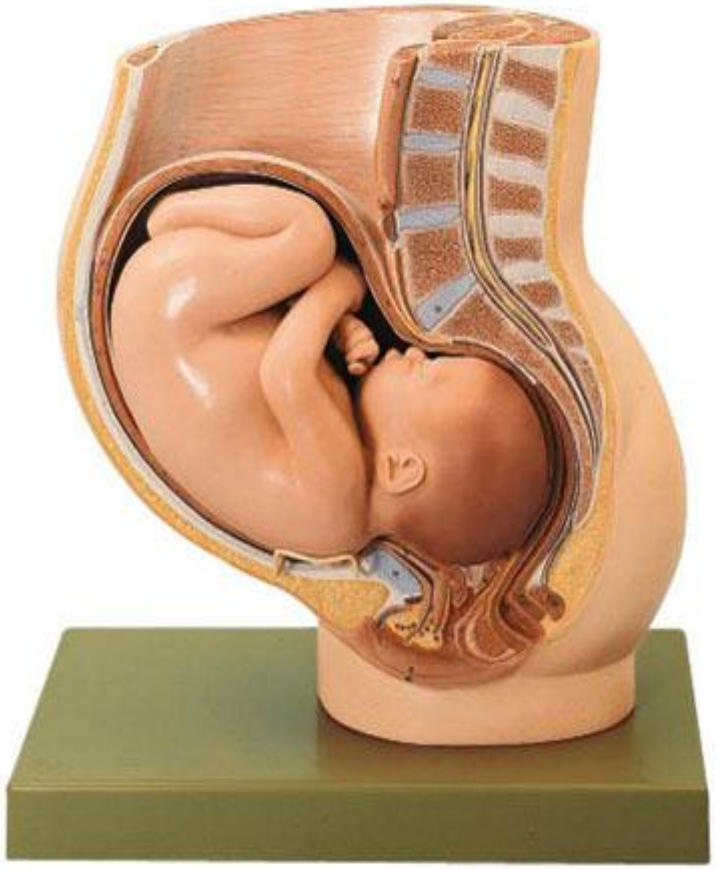


Objectives

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

- 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 human labor.

Labor

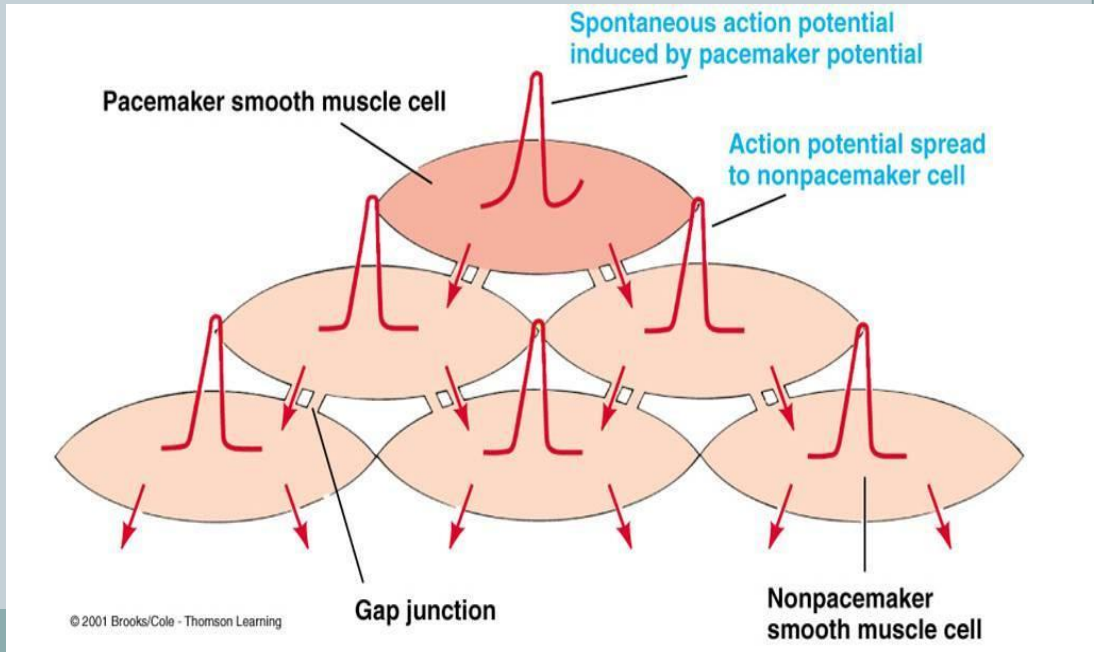
- Definition
  - Uterine contractions that lead to expulsion of the fetoplacental unit to the extrauterine environment.

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

❖ Does the non-pregnant uterus contract?

Labor

- Uterus is spontaneously active.
- Spontaneous depolarization of pacemaker cells (Telocytes?).
- Gap junctions spread depolarization.
- Exact trigger is unknown
  - Hormonal changes
  - Mechanical changes



Hormonal changes

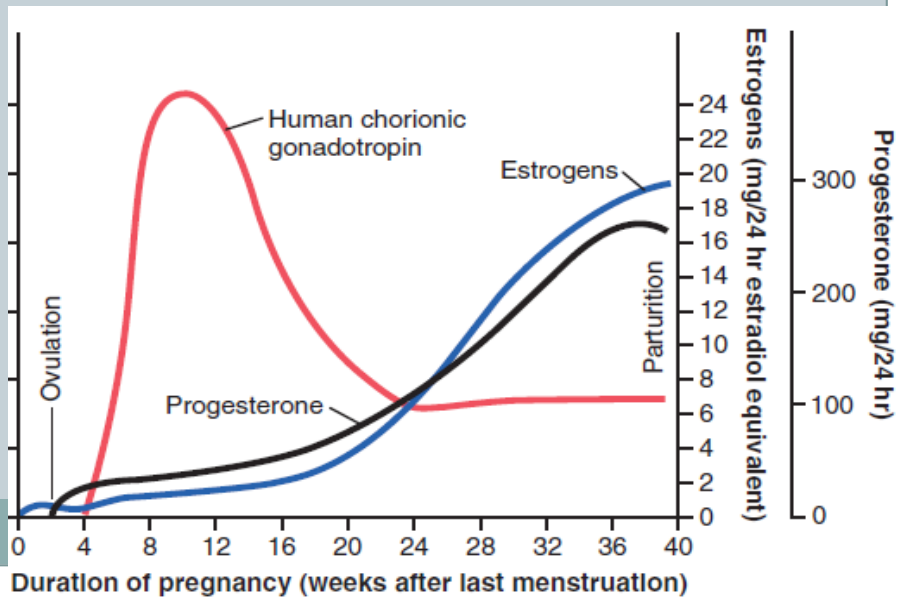
Increased ratio of estrogens to progesterone

- Progesterone & Estrogen
  - Progesterone inhibits while estrogen stimulates uterine contractility
- From 7th month till term

- Progesterone secretion remains constant or decreases slightly

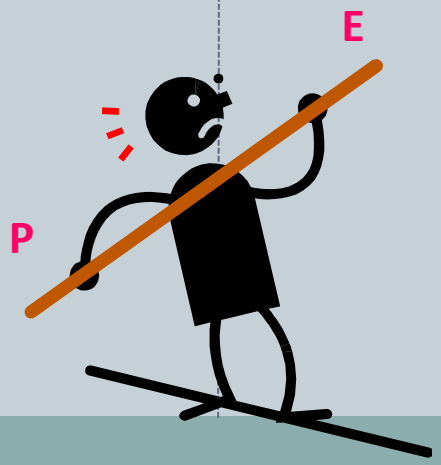
- Estrogen secretion increases continuously

- The estrogen/progesterone ratio increases sufficiently toward the end of pregnancy to be at least partly responsible for the increased contractility of the uterus



Hormonal changes

- **Progesterone**
  - ▼ GAP junctions
  - ▼ Oxytocin receptors
  - ▼prostaglandins
  - ▲ negativity of the resting membrane potential
- **Estrogen**
  - ▲ GAP junctions with onset of labour
  - ▲ Oxytocin receptors
  - ▲ Prostaglandins



Hormonal changes

- **Oxytocin**
  - Dramatic ▲of oxytocin receptors (200 folds).
    - gradual transition from passive relaxed to active excitatory muscle (↑ responsiveness).
  - Increase in oxytocin secretion at labor by posterior pituitary gland.
  - Oxytocin increases uterine contractions by
    - Directly on its receptors
    - Indirectly by stimulating prostaglandin ($PGF_{2\alpha}$) production

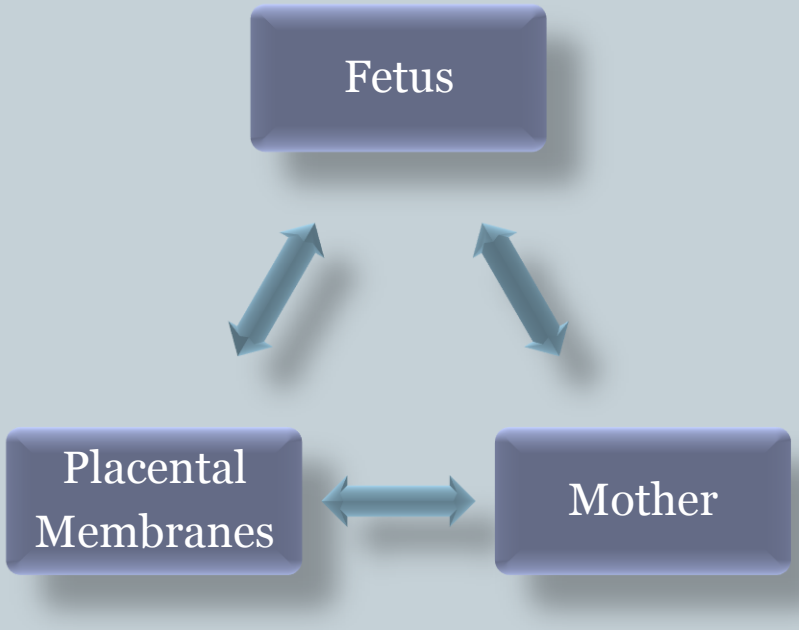
Hormonal changes

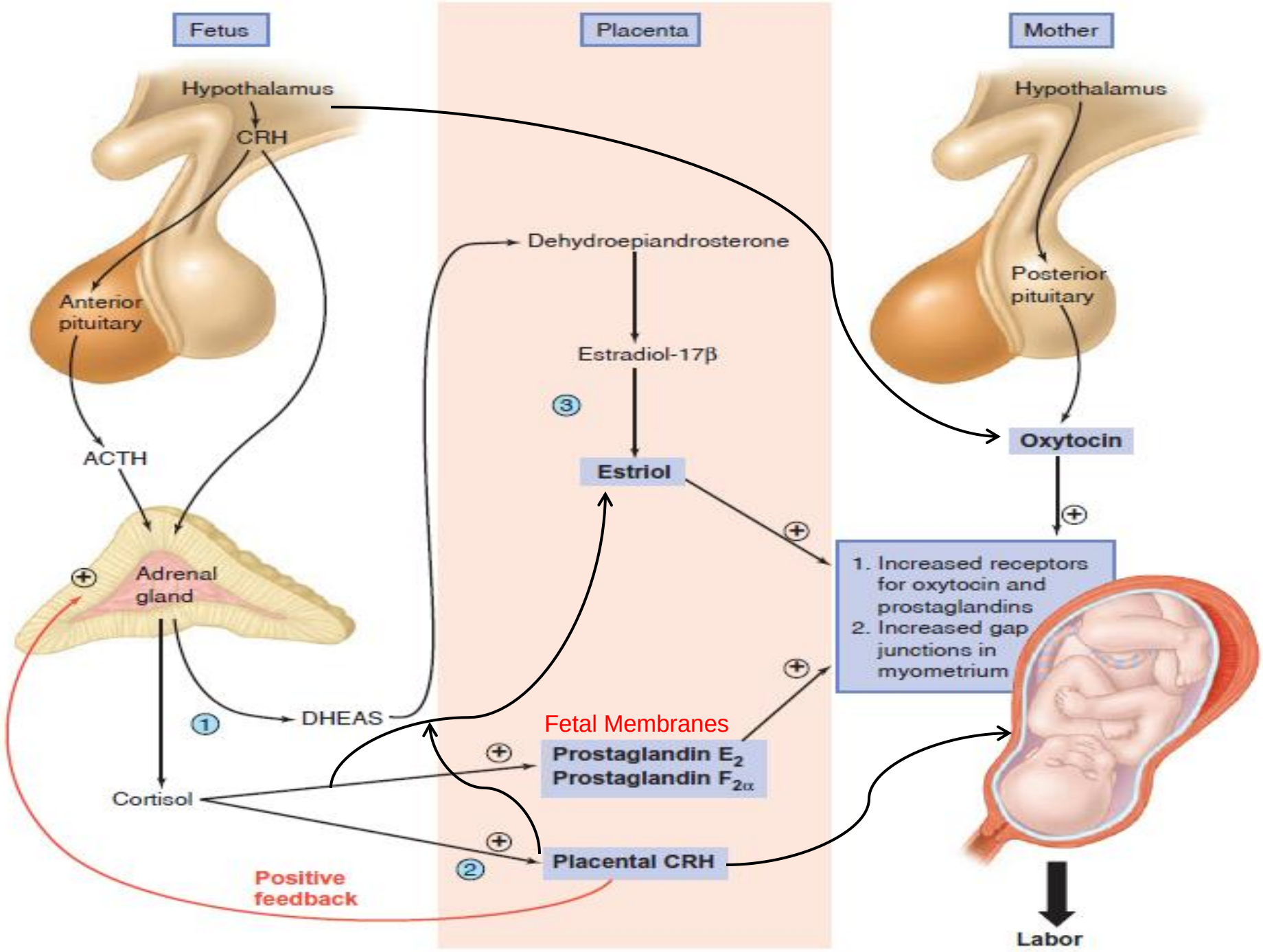
- **Prostaglandins**
  - Central role in initiation & progression of human labour
  - Locally produced (intrauterine), paracrine
  - Oxytocin and cytokines stimulate its production
  - Prostaglandin stimulates uterine contractions by:
    - Direct effect:
      - Through their own receptors
      - Upregulation of myometrial gap junctions
    - Indirect effect:
      - Upregulation of oxytocin receptors

Labor

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

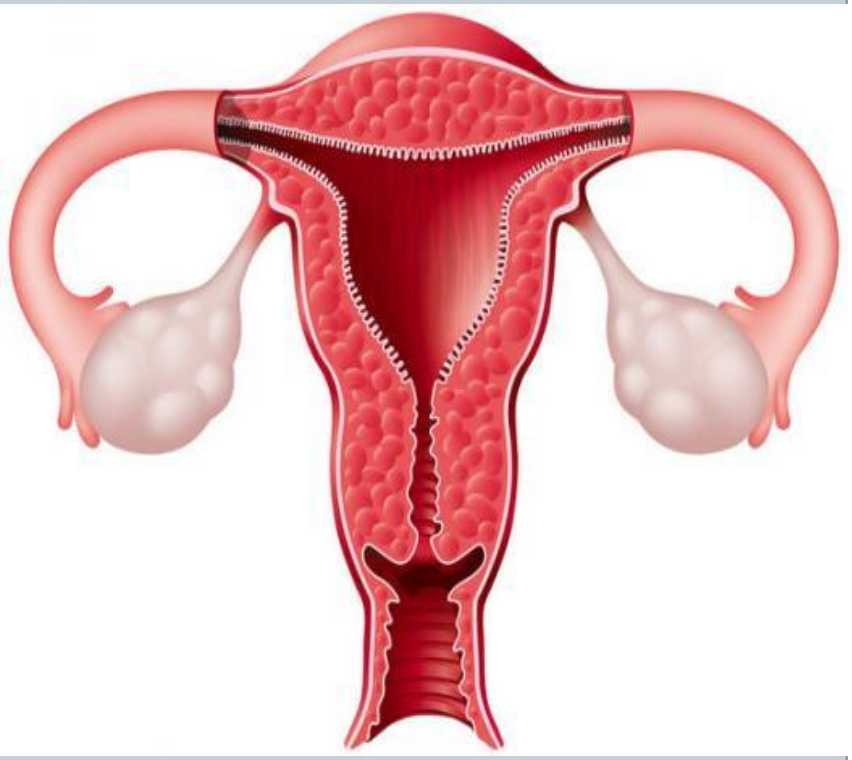
Complex interactions




Fetus
Placenta
Mother
Hypothalamus
CRH
Anterior pituitary
ACTH
Adrenal gland
DHEAS
Cortisol
Dehydroepiandrosterone
Estradiol-17β
Estriol
Hypothalamus
Posterior pituitary
Oxytocin
1. Increased receptors for oxytocin and prostaglandins
2. Increased gap junctions in myometrium
Fetal Membranes
Prostaglandin E_2
Prostaglandin $F_{2\alpha}$
Placental CRH
Positive feedback
Labor

Mechanical changes

- **Stretch of the uterine muscle**
  - Increases contractility
    - Fetal movements
    - Multiple pregnancy / size of uterus
- **Stretch of the cervix**
  - Increases contractility (reflex)
    (Positive feedback mechanism)
  - Membrane sweeping & rupture
  - Fetal head



Onset of Labor

Positive feedback mechanisms

Labor contractions obey all the principles of ***positive feedback:***

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

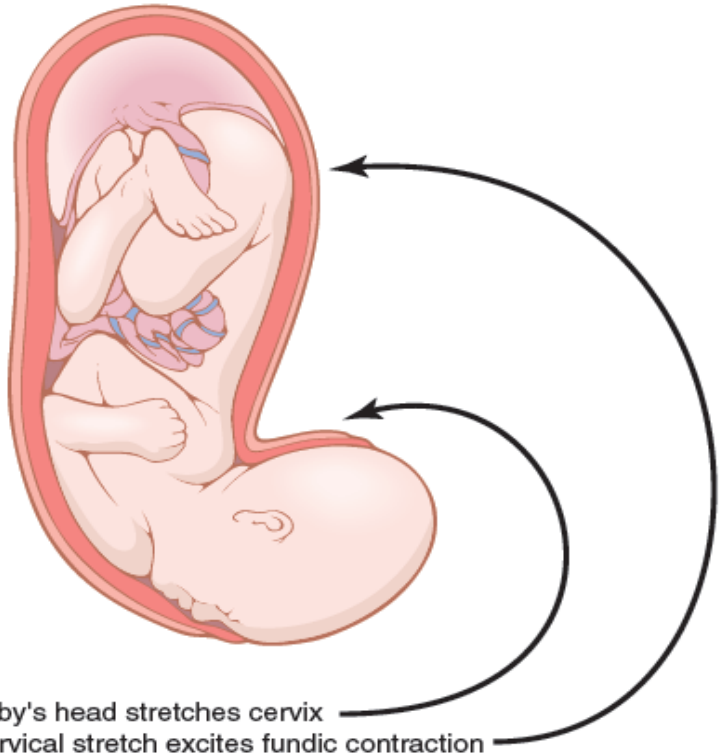
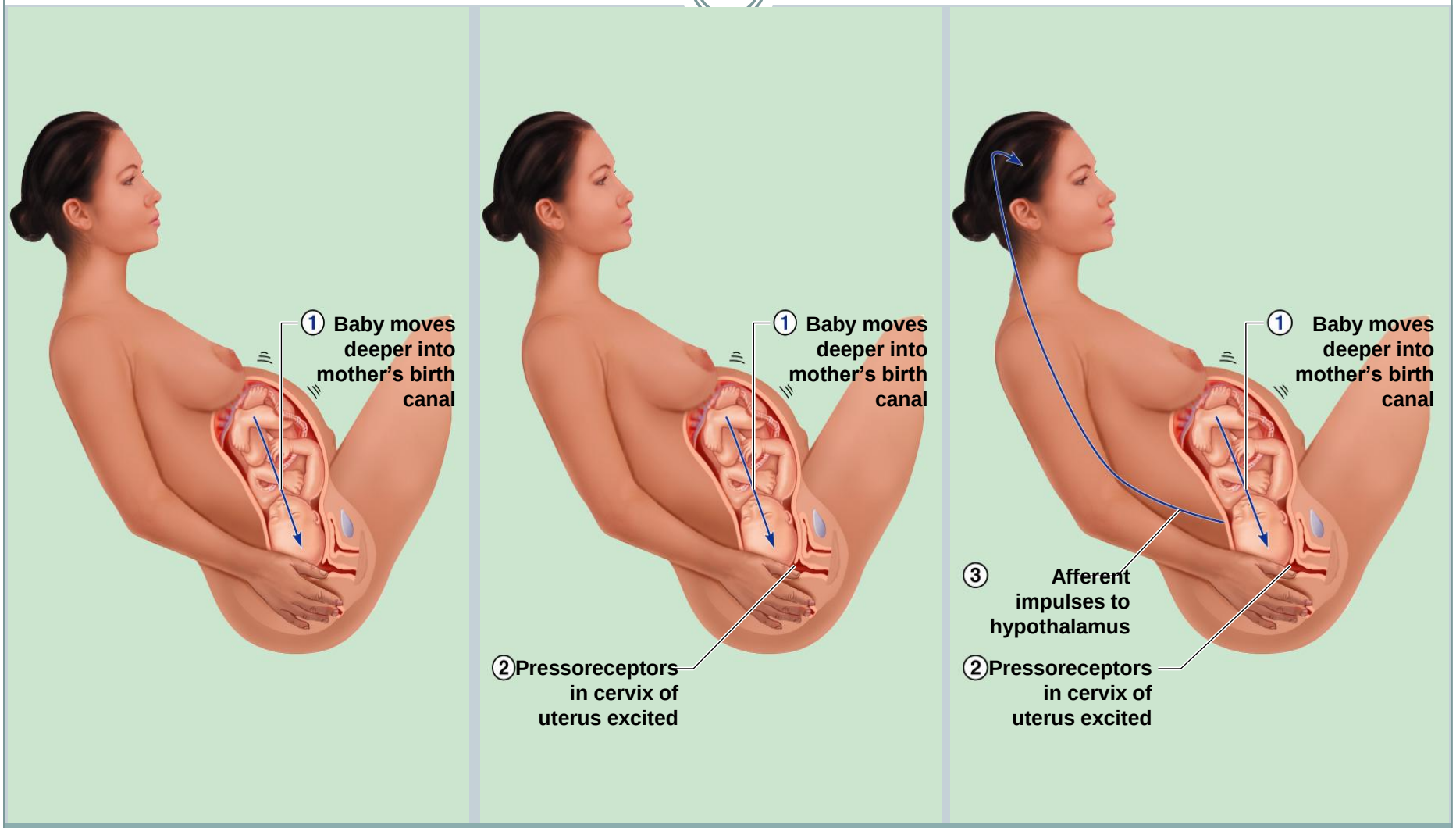
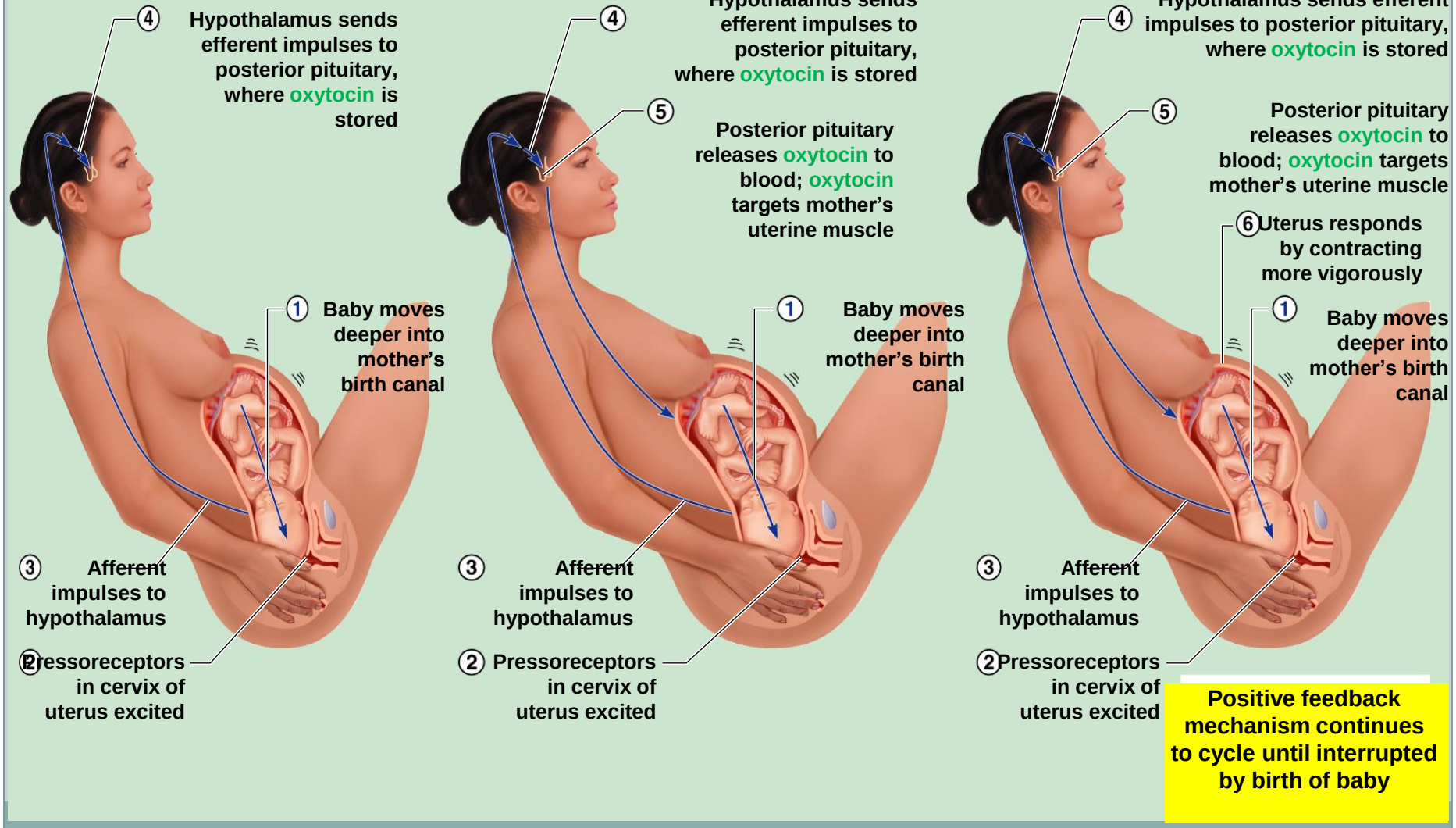


Figure 83-9. Theory for the onset of intensely strong contractions during labor.

Onset of Labor



Onset of Labor



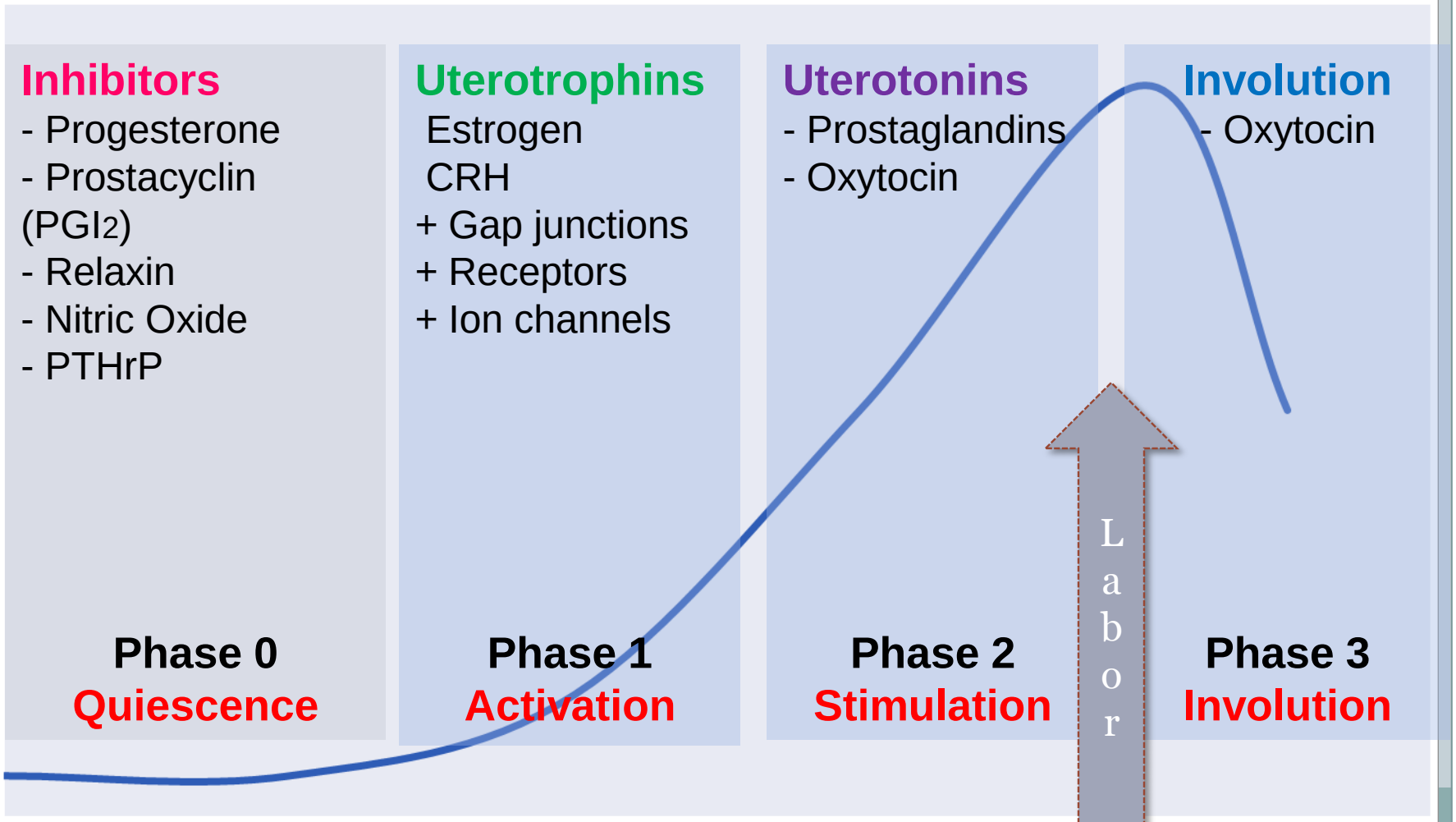
Onset of labor

- During pregnancy
  - Periodic episodes of weak and slow rhythmical uterine contractions (Braxton Hicks) 2nd trimester
- Towards the end of pregnancy
  - Uterine contractions become progressively stronger.
  - Uerine contractions change suddenly, within hours, to become strong contractions leading to cervical stretching and force the baby through the birth canal.

Mechanism of Labor

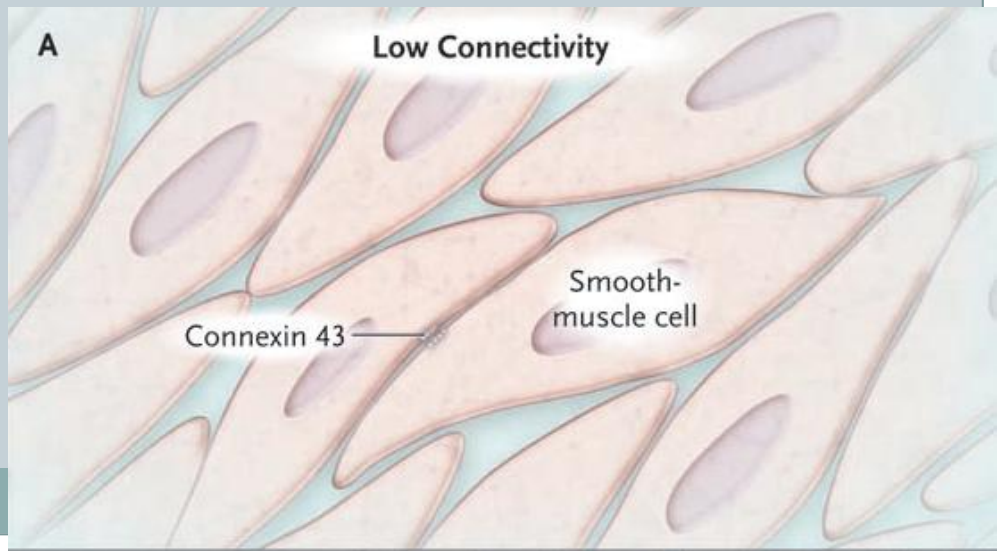
- Contractions start at the fundus and spread to the lower segment
- The intensity of contractions is strong at the fundus but weak at the lower segment
- In early stages: 1 contraction/ 30 minuets
- As labor progresses: 1 contraction/ 1-3 minutes
- Abdominal wall muscles contract
- Rhythmical contractions allow blood flow

Mediators of Uterine Activity



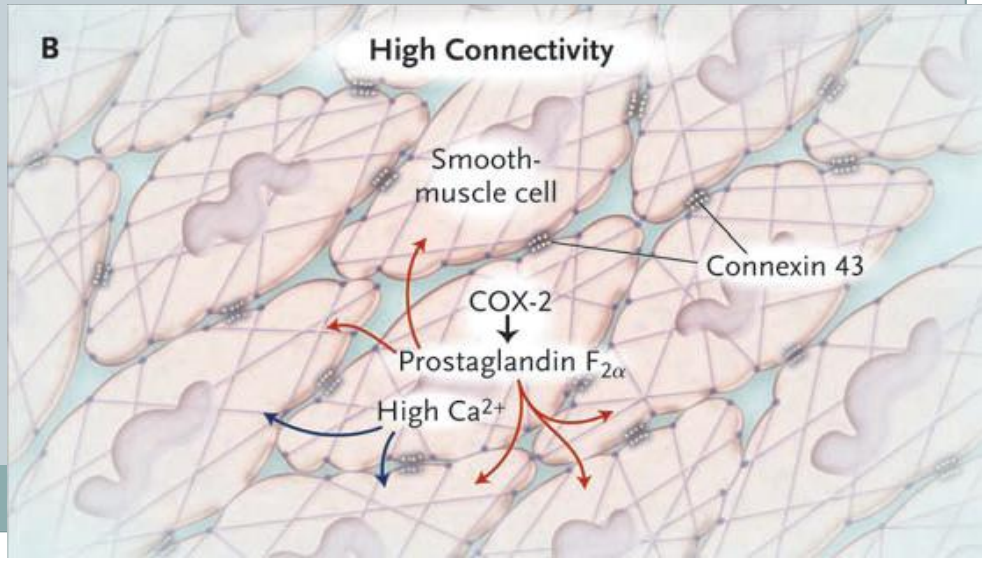
Phases of uterine activity

- **Quiescence**
  - Occurs during early pregnancy.
  - Increase cAMP level.
  - Increase production of:
    - Prostacyclin (PGI_2), Nitric oxide (NO), and PTHrP which can all cause uterine relaxation.



Phases of uterine activity

- **Activation**
  - Occurs in third trimester
  - Promotes a switch from quiescent to active uterus
  - Increase excitability & responsiveness to stimulators by
    - Increasing expression of gap junctions
    - Increasing receptors and ion channels
      - Oxytocin receptors
      - PG receptors

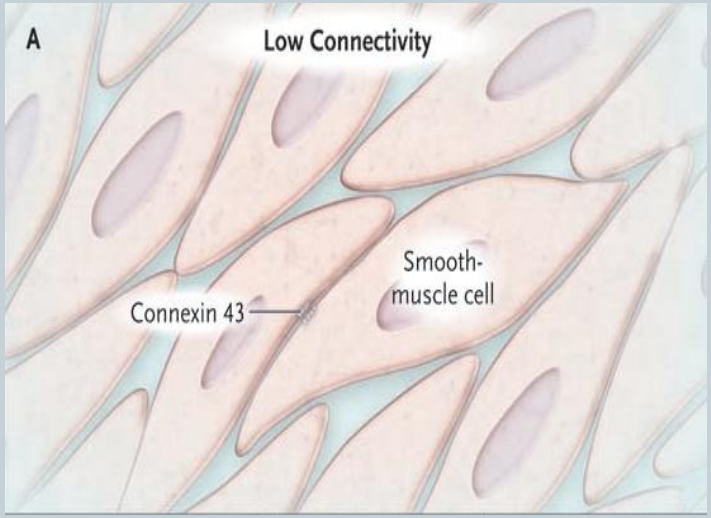


Phases of uterine activity

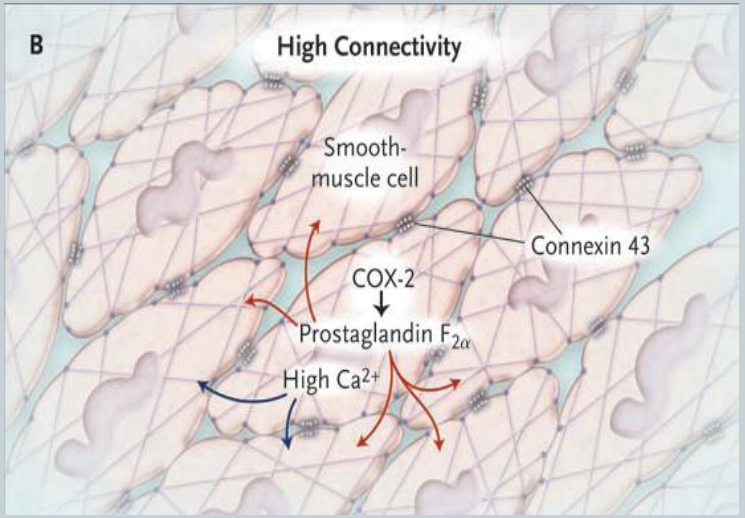
- **Stimulation**
  - Occurs in the last 2-3 gestational weeks
  - Increase in synthesis of uterotonins
    - Oxytocin
    - Prostaglandins
- **Involution**
  - Pulsatile release of oxytocin
  - Delivery of the placenta
  - Involution of the uterus
    - Occurs 4-5 weeks after delivery
    - Lactation helps in complete involution

Phases of uterine activity (summary)

Phase 0 (Quiescence)



Phase 1 (Uterotrophins)



Phase 3 (Involution)

Phase 2 (Uterotonins

Clinical Stages of Labor

Stage-1 **(Cervical dilation)**

Stage-2 **(Descent of the fetus)**

Stage-3 **(Delivery of the placenta)**

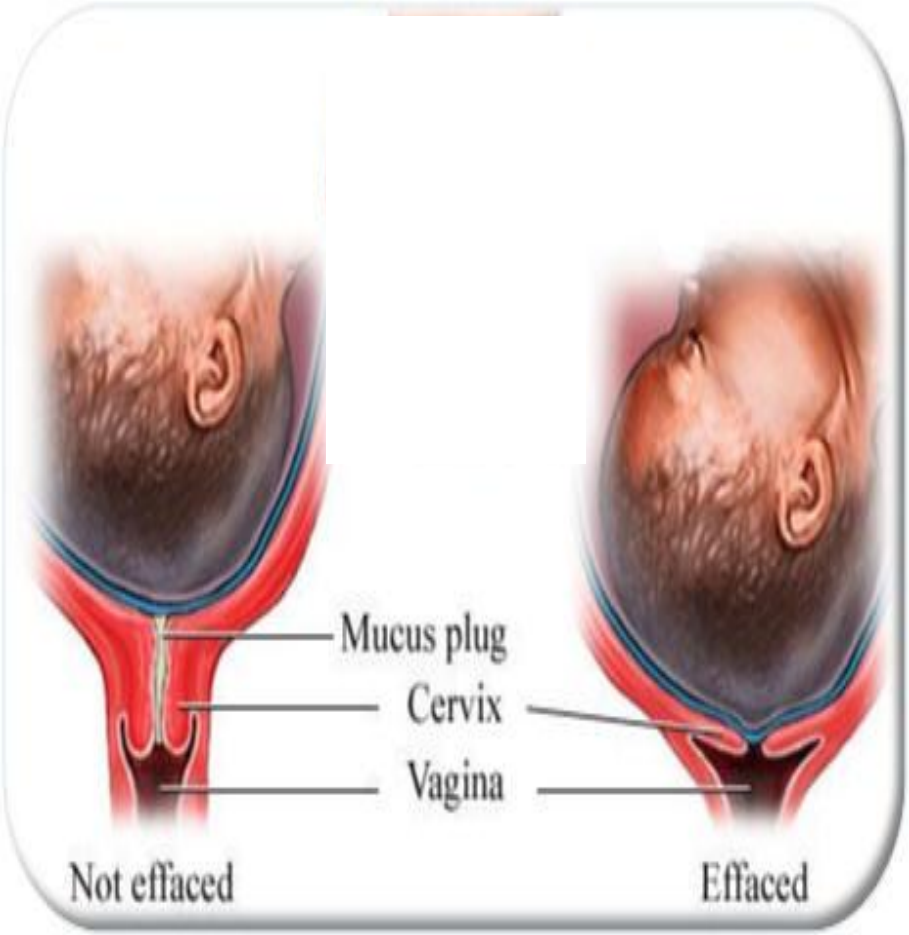
Clinical Stages of Labor

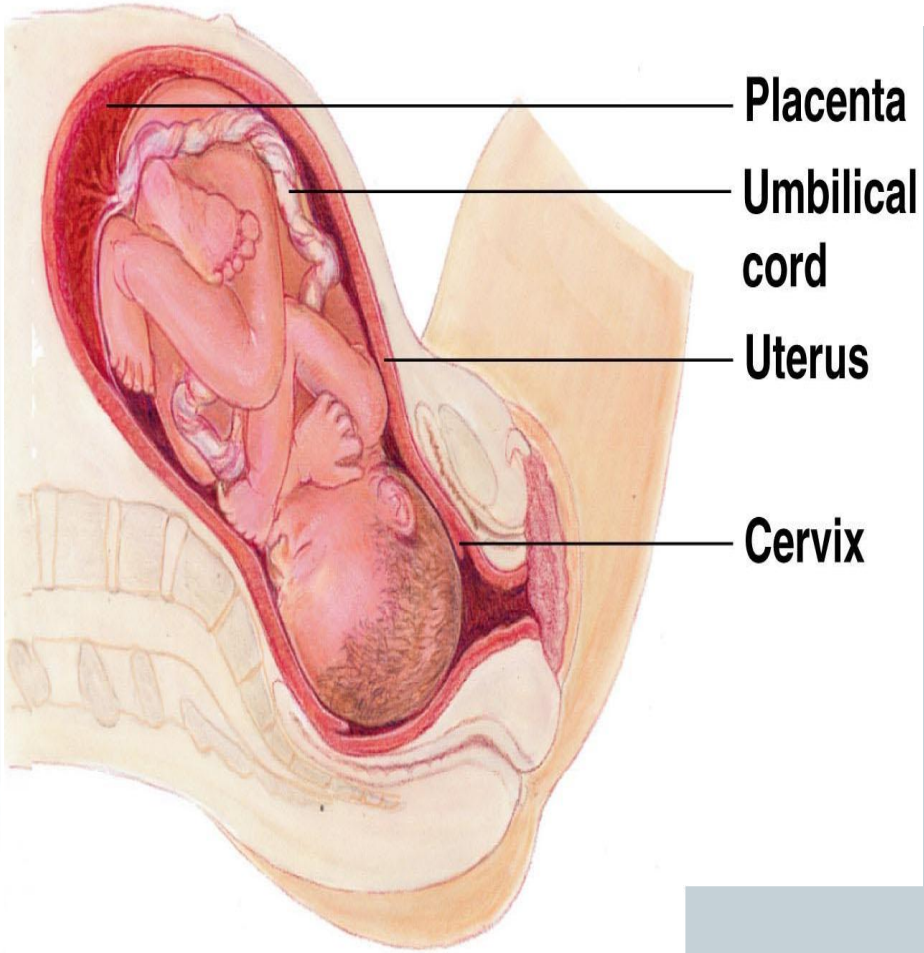
Stage-1 (Cervical dilation)

- Cervix becomes dilated
- Full dilation is 10 cm
- Uterine contractions begin and increase
- Cervix softens and effaces (thins)
- The amnion ruptures (“breaking the water”)
- It is the longest stage of labor.

  6–20 hrs (primipara), 6-14 hrs (multipara)

Clinical Stages of Labor





① Dilation of the cervix

Clinical Stages of Labor

Stage-2 (Descent of the fetus)

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

Clinical Stages of Labor

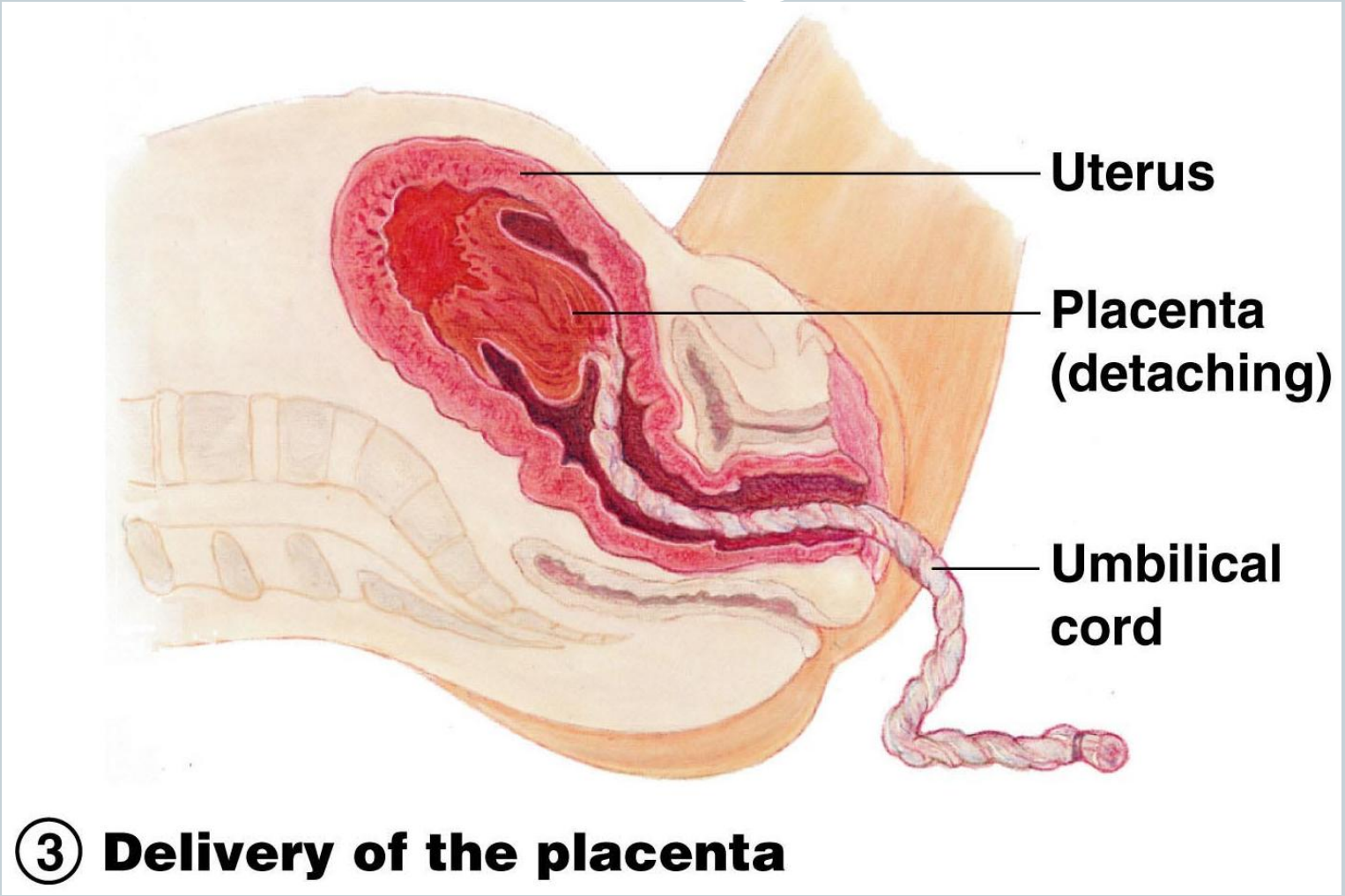
② **Expulsion: delivery of the infant**

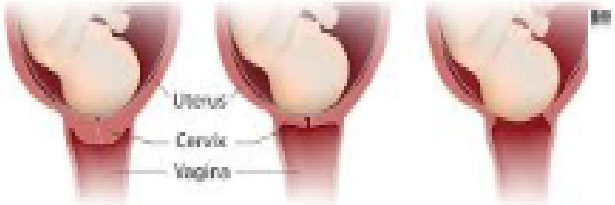
Clinical Stages of Labor

Stage-3 (Delivery of the placenta)

- Begins with delivery of the fetus and ends with expulsion of the placenta
- After birth—placenta attached to the fetal membranes are delivered.
- All placental fragments should be removed to avoid postpartum bleeding.
- Usually accomplished within 15-30 minutes after birth.

Clinical Stages of Labor

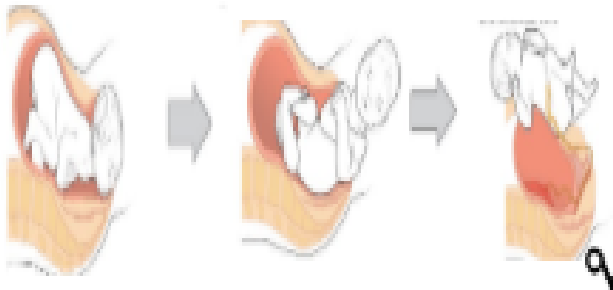




Not effaced
Not dilated

fully effaced
1 cm dilated

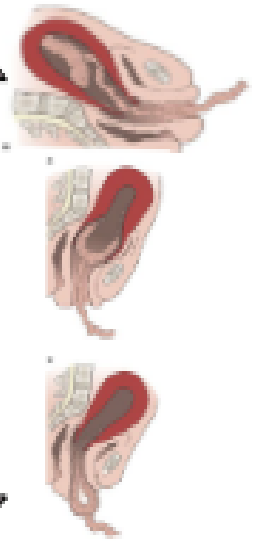
Fully effaced
Fully dilated



Stage 1

Stage 2

Stage 3



Stage 1: longest
Start: strong(true) contractions
End: fully effaced (>90%) & dilated cervix (>9cm)
Stage 2:
Start: fully dilated cervix 10 cm
End: the cut of umbilical cord
Stage 3: shortest
Start: after the cut of umbilical cord
End: the placenta delivery

The End

Thank You