ONSET AND PHYSIOLOGY OF LABOR

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Parturition

- **Definition**
  - Uterine contractions that lead to expulsion of the fetus to extrauterine environment
  - Towards the end of pregnancy the uterus become progressively more excitable and develops strong rhythmic contractions that lead to expulsion of the fetus.
Parturition

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

- Estrogen & Progesterone
  - Progesterone inhibit uterine contractility
  - Estrogen stimulate uterine contractility
- From 7th month till term
  - Progesterone secretion remain constant
  - Estrogen secretion continuously increase
  - Increase estrogen/progesterone ratio
Hormonal changes

- **Progesteron**
  - ▼ GAP junctions
  - ▼ Oxytocin receptor
  - ▼ prostaglandins.
  - ▲ resting mem. 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
- Oxytocin increase uterine contractions by
  - Directly on its receptors
  - Indirectly by stimulating prostaglandin production
Hormonal changes

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

Diagram showing the hormonal interactions involved in parturition:

- **Fetus**: Hypothalamus (CRH), Anterior pituitary (ACTH), Adrenal gland (DHEAS, Cortisol), Placental CRH.
- **Placenta**: Estradiol-17β, Estriol, Prostaglandin E₂, Prostaglandin F₂α.
- **Mother**: Hypothalamus (Oxytocin), Posterior pituitary (Oxytocin), Adrenal gland.

Key points:
1. Increased receptors for oxytocin and prostaglandins.
2. Increased gap junctions in myometrium.

Labor induction mechanisms:
- Positive feedback loop involving CRH and oxytocin.
- Prostaglandin E₂ and F₂α regulate uterine contractions.
Mechanical changes

- **Stretch of the uterine muscle**
  - Increases contractility
    - Fetal movements
    - Multiple pregnancy

- **Stretch of the cervix**
  - Increases contractility (reflex)
    - Membrane sweeping & rupture
    - Fetal head
      - Positive feedback mechanism
Positive feedback mechanism

- Contraction of uterus wall force baby's head or body into the cervix, thus increasing.
- Stretching of cervix
- Receptors: Stretch-sensitive nerve cells in cervix send input (nerve impulses) to the control center.
- Control center: Brain interprets input and releases oxytocin.
- Oxytocin
- Effectors: Muscles in wall of uterus contract more forcefully, resulting in more stretching of cervix.
- Baby's body stretches cervix more

Positive feedback: Increased stretching of cervix causes release of more oxytocin, which results in more stretching of cervix.
Phases of parturition

- Phase 0
  - Pregnancy: uterus is relaxed (quiescent)

- Phase 1
  - Activation

- Phase 2
  - Stimulation: stage 1 & stage 2

- Phase 3 = stage 3
  - Delivery of the placenta and uterine involution
Phases of parturition

- Phase 0 (pregnancy)
  - Increase in cAMP level
  - Increase in production of
    - Prostacyclin (PGI$_2$) cause uterine relaxation
    - Nitric oxide (NO) cause uterine relaxation

Adapted from Smith, 2007
Phases of parturition

- **Phase 1 (activation)**
  - Occurs in third trimester
  - Promote a switch from quiescent to active uterus
  - Increase excitability & responsiveness to stimulators by
    - Increase expression of gap junctions
    - Increase G protein-coupled receptors
      - Oxytocin receptors
      - Increase PGF receptors
Phases of parturition

- **Phase 2 (stimulation)**
  - Occurs in last 2-3 gestational weeks
  - Increase in synthesis of
    - Cytokines
    - Prostaglandins
    - Oxytocin
  - Includes 2 stages:
    - Stage 1
    - Stage 2
Phases of parturition

- **Phase 3 (uterine involution)**
  - Pulsatile release of oxytocin
  - Delivery of the placenta
  - Involution of the uterus
    - Occurs in 4-5 weeks after delivery
    - Lactation helps in complete involution
Mechanism of parturition

- 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
Onset of labor

- During pregnancy
  - Periodic episodes of weak and slow rhythmical uterine contractions (Braxton Hicks) 2\textsuperscript{nd} trimester

- Towards end of pregnancy
  - Uterine contractions become progressively stronger
  - Suddenly uterine contractions become very strong leading to:
    - cervical effacement and dilatation
Cervical effacement and dilatation
Stages of labor

- **Stage 1:**
  - Commences with the onset of labour and terminates when the cervix has reached full dilatation and membranes ruptured (lasts 8-24 hours).

- **Stage 2:**
  - Stage of expulsion begins at full cervical dilatation and ends with expulsion of the fetus (lasts 1-30 minutes).

- **Stage 3:**
  - Begins with the delivery of the child and ends with the expulsion of the placenta.
Stages of labor

1. Dilation stage
2. Expulsion stage
3. Placental stage
New arrival