FUNCTIONS OF PLACENTA
&
MATERNAL CHANGES DURING PREGNANCY
PARTURITION.

Learning Objectives

After completion of this lecture, the student should be able to:
• Understand the structure of placenta
• Discuss the function of placenta
• Understand the different maternal changes during pregnancy.
• Describe parturition and its stages.

Placenta

(placenta means "flat, slab-like")
• An organ that connects the developing fetus to the uterine wall to allow nutrient uptake, waste elimination, and gas exchange via the mother's blood supply.

Components of Placenta

A fetomaternal organ having two components:
• Fetal component: the villous chorion.
• Maternal Component: the decidua basalis.

Placental Circulation

• Circulation of blood through placenta during intrauterine life.
• Serving fetal needs for aeration, absorption, and excretion.
• Placental blood flow is increased at term and amounts to 500 ml/min (80% of the uterine perfusion).
The placental barrier

- Structures that separate the maternal and fetal blood.
  **In the first trimester** it consists of:
  - syncytiotrophoblast,
  - cytotrophoblast (Langhans' cells),
  - villus mesenchyma and
  - fetal capillary walls.
  - **During the 4th month** the cytotrophoblast disappears from the villus wall.

Functions of the placenta

- **Nutrition**: Transfer of nutrients and oxygen from mother to fetus and transfer of waste products and carbon dioxide back from fetus to mother.
- **Endocrine function**: Hormone (secreted by syncytiotrophoblast of chorionic villi) important during pregnancy are:
  - Human chorionic gonadotropin.
  - Human placental lactogen
  - Estrogen
- Progesterone.
- **Immune function &**
- **Blood reservation.**

<table>
<thead>
<tr>
<th>Human Chorionic Gonadotropin (hCG):</th>
<th>Human Placental Lactogen (hPL):</th>
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<tr>
<td>First placental hormone produced.</td>
<td>Lactogenic and growth-promoting properties.</td>
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<tr>
<td>Found in maternal blood and urine as early as first missed menstrual period through about 100th day of pregnancy.</td>
<td>Promotes mammary gland growth in preparation for lactation.</td>
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<tr>
<td>Analyzed by pregnancy test; a false-negative result may be obtained before or after this period.</td>
<td>Regulates maternal glucose, protein, fat levels.</td>
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<tr>
<th><strong>Estrogen.</strong></th>
<th><strong>Progesterone.</strong></th>
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<td>“Hormone of woman&quot; because it influences the female appearance.</td>
<td>&quot;Hormone of mothers“</td>
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<tr>
<td>Contributes to woman's mammary gland development for lactation.</td>
<td>Necessary to maintain endometrial lining of uterus during pregnancy.</td>
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<td>Stimulates uterine growth to accommodate growing fetus.</td>
<td>Prevents preterm labor by reducing myometrial contraction.</td>
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<td></td>
<td>High during pregnancy.</td>
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**Immune system:**

- IgG antibodies pass through the human placenta, providing protection to fetus.
• Placenta and fetus regarded as a foreign allograft inside the mother, must evade from attack by mother's immune system.

**Blood Reservation:**
Reservoir of blood for the fetus, delivering blood to it in case of hypotension and vice versa.

**Pregnancy**
Carrying of one or more offspring, known as a fetus or embryo, inside the womb of a female

**Maternal physiological changes in pregnancy**
Normal adaptations that a woman undergoes during pregnancy to better accommodate the embryo or fetus.
- Hormonal
- Musculoskeletal
- Physical
- Cardiovascular
- Respiratory
- Hematology
- Metabolic
- Nutrition
- Renal
- Gastrointestinal

**Hormonal Changes in Pregnancy**

• Progesterone and estrogen levels rise continually throughout pregnancy, suppressing the hypothalamic axis and menstrual cycle.
• Increased **human chorionic gonadotropin (β-hCG):** produced by placenta.
• Prolactin levels increase due to maternal pituitary gland enlargement by 50%.
• Parathyroid hormone is increased.
• Cortisol and aldosterone also increase.
Human placental Lactogen (hPL):

- Stimulates lipolysis and fatty acid metabolism by woman, conserving blood glucose for use by fetus.
- Decrease maternal tissue sensitivity to insulin, resulting in gestational diabetes.

**Musculoskeletal Changes in Pregnancy**

Body's posture changes as the pregnancy progresses.
- Pelvis tilts and the back arches to help keep balance.
- On average, a woman's foot can grow by a half size or more during pregnancy.
- Influences of increased hormones such as estrogen and relaxin initiate the remodeling of soft tissues, cartilage and ligaments.

**Physical changes**

- Gain in weight (5 pounds (2.3 kg) to over 100 pounds (45 kg).
- Enlarging uterus, growing fetus, placenta and liquor amnii, acquisition of fat and water retention, all contribute to this increase in weight.
- Breasts increasing two cup sizes.

**Cardiovascular**

Blood volume slowly increase by 40-50%.
- Increase in heart rate (15 beats/min more than usual), stroke volume, and cardiac output.
- Cardiac output increases by about 50%.
- Systemic vascular resistance drops due to smooth muscle relaxation and overall vasodilation.
- Red blood cell numbers increase due to increased erythropoietin levels.
**Respiratory**

PaO\(_2\) in arterial blood increases slightly and PaCO\(_2\) decreases during pregnancy.

- Respiratory alkalosis are compensated for by increased excretion of bicarbonate via urine, maintaining a normal acid-base balance.
- Decreased functional residual capacity due to compression of diaphragm by uterus.
- Decreased total lung capacity (TLC) by 5% and decreased expiratory reserve volume.
- Dyspnea (shortness of breath) at some point during pregnancy.

**Hematology**

Plasma volume increases by 50%.

- red blood cell volume increases by 20-30%.
- Hematocrit decreases; not a true decrease, but rather due to dilution.
- White blood cell count increase may peak at over 20 mg/mL.
- Decrease in platelet concentration to 100-150 mil/mL.
- Edema, or swelling, of feet.
- Increased risk for developing blood clots and embolisms

**Metabolic**

Protein metabolism and carbohydrate metabolism are affected.

- One kilogram of extra protein is deposited, with half going to the fetus and placenta, and another half going to uterine contractile proteins, breast glandular tissue, plasma protein, and haemoglobin.
  Changes are caused by steroid hormones, lactogen, and cortisol.
- Maternal insulin resistance can lead to gestational diabetes.

**Nutrition**

A caloric increase of 300 kcal/day and an increase in protein to 70 or 75 g/day is required.

- Increased folate requirement from 0.4 to 0.8 mg/day (important in preventing neural tube defects).
- Weight gain of 20 to 30 lb (9.1 to 14 kg) is experienced.
**Renal**

Increase in kidney and ureter size.
- Glomerular filtration rate commonly increases by 50%.
- Plasma sodium does not change because this is offset by the increase in GFR.
- Decreased blood urea nitrogen (BUN) and creatinine and glucosuria (due to saturated tubular reabsorption).
- Renin-angiotensin system is upregulated, causing increased aldosterone levels.

**Gastrointestinal**

Experience nausea and vomiting (morning sickness); which may be due to elevated b-Hcg and should resolve by 14 to 16 weeks.
- Prolonged gastric empty time, decreased gastroesophageal sphincter tone, which can lead to acid reflux, and decreased colonic motility, which leads to increased water absorption and constipation.

**Parturition or Labor**

The physiological process by which the pregnant uterus delivers the fetus and placenta from the maternal organism.

Signs of approaching parturition
A. Pelvic ligament relaxes.
B. Enlargement and edema of the vulva.
C. Mammary Activity
   - Milk Leakage
   - Colostrum.
D. Mother seeks isolation

**Initiation of parturition**

A. Complex, not fully understood.
B. Primarily fetal control.
C. Endocrine, Neural, & Mechanical.
   a. Fall in Progesterone.
   b. Rise in Estradiol.
   c. Increase in Uterine Volume.
   d. Release of Oxytocin.
   e. Release of PGF2a.
   f. Activation of fetal hypothalamic-pituitary-adrenal axis.
      i. Fetal Cortisol is strongly suggested as signal.

3. Mechanics of parturition

A. Myometrial contractions.
B. Dilation of Cervix

**Stages of Labour**

a. Dilation of cervix:
   - Regular uterine contractions.
   - Maternal restlessness.
   - Changes in fetal position.

b. Expulsion of fetus
   - Strong uterine contractions.
   - Strong abdominal contractions.
   - Maternal recumbancy.
   - Rupture of chorioallantois.
   - Appearance of Amnion at Vulva.
   - Rupture of Aminion.
   - Delivery of fetus.

c. Expulsion of placenta:
   - Uterine contractions decrease in strength
   - Maternal straining ends
   - Loosening of Chorionic villi from uterus
   - Inversion of chorioallantois
   - Expulsion of fetal membranes.
Summary

Placenta:

- Connects developing fetus to maternal uterine wall.
- Two components
  - Fetal component (villus chorion) and
  - Maternal component (decidua basalis).

- **Functions:** nutrition, endocrine function, immune function & blood reservation.

- **Secretes:** human chorionic gonadotropin (hCG), human placental lactogen, estrogen & progesterone.

- Blood volume, plasma volume, heart rate, stroke volume and cardiac output are increases during pregnancy.

- Pregnant women require a caloric increase of 300 kcal/ day.