

# Maternal physiology during pregnancy

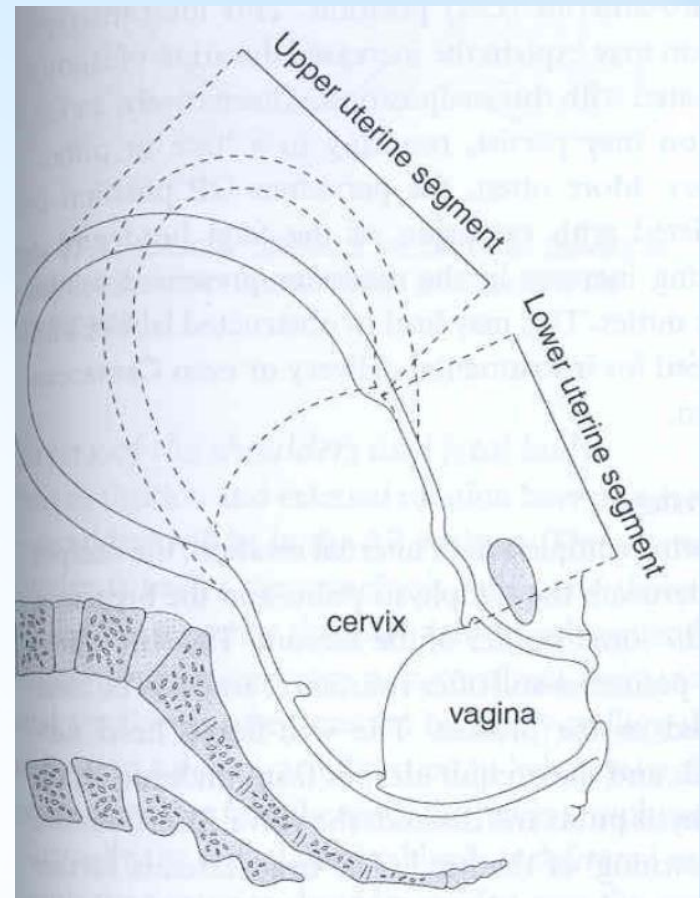
There are many physiologic changes in pregnancy. Some mimic the signs, symptoms, or laboratory finding of disease in the nonpregnant woman yet are normal in pregnancy. Therefore, knowledge of normal maternal physiologic changes helps avoid unnecessary diagnostic or therapeutic interventions.

- \* Uterine enlargement in pregnancy
  - \* by hypertrophy, hyperplasia and stretching of the muscle fibres.
  - \* from 50-60g to almost 1000g at term
- \* At 7 weeks - the size of an egg;
- \* At 10 weeks it is the size of an orange and fills the entire pelvis.
- \* At 12 weeks it rises out the pelvis and palpable abdominally just above the symphysis pubis



# Reproductive system.

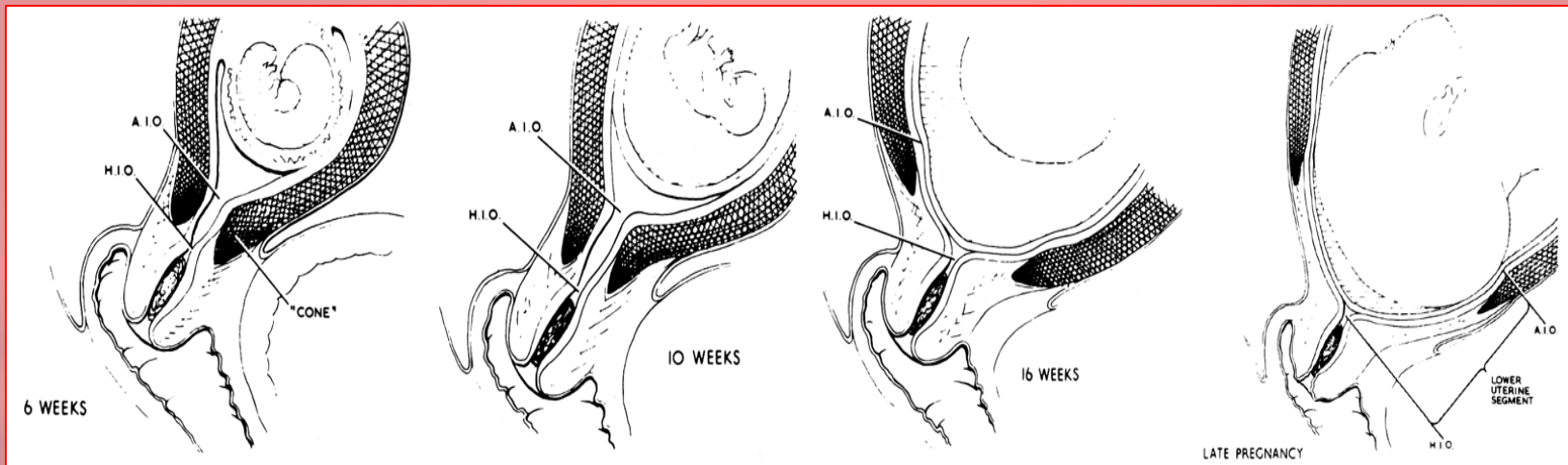
- \* The lower uterine segment (LUS) is the part of the uterus and the upper cervix which lies between the attachment of the peritoneum of the uterovesical pouch superiorly & the internal cervical os inferiorly.
- \* The isthmus of the uterus, the lower extremity of which joins with the cervical canal and during pregnancy expands to become the lower part of the uterine cavity



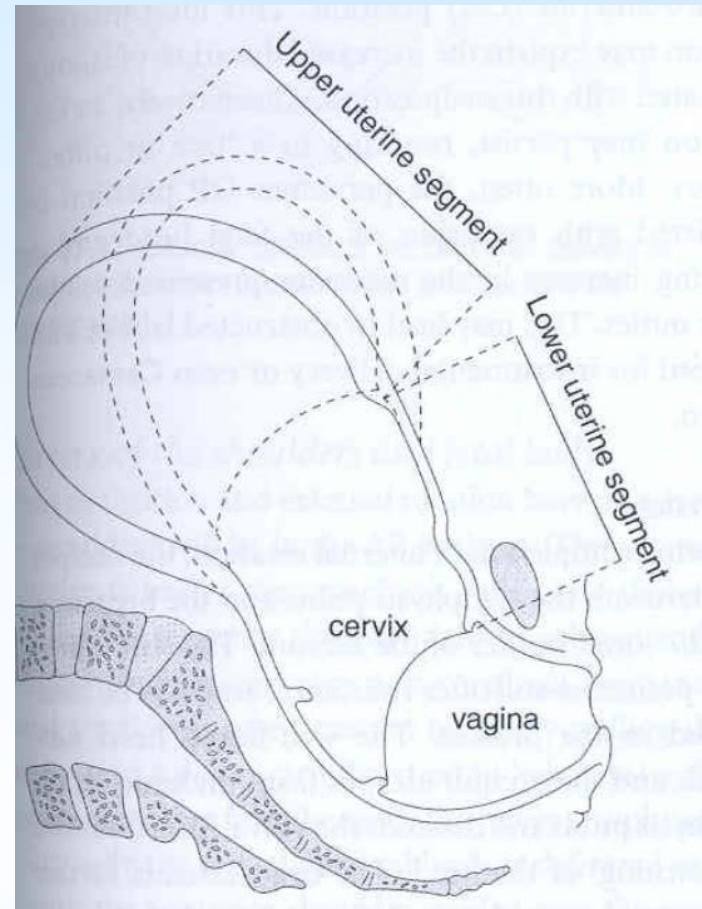
# The LUS

# \* Formation of the LUS

- \* With increasing gestation, there is increased stretching of the uterine muscle fibres.
- \* This results in the formation of the lower segment in the 3rd trimester (28 – 40 weeks).



- \* This part of the uterus is thinner contain less muscle fibres and blood vessels.
- \* This is the site for caesarean section incision.
- \* The placenta is attached to the more vascular and thicker upper segment.
- \* i.e LUS is not the normal site for placental implantation.



# Implications of the LUS

# Reproductive tract (2)

- ***Braxton Hicks contraction:***  
sporadic, irregular, asymmetrical, and painless, low pressure, lasting < 30 sec some times called false labour.

# Characteristics of True and False Labor.

- Regular Contractions
- Stronger, longer, closer together
- Bloody show often present
- Cervix effaced and dilated
- Head is fixed between contractions
- Sedation does not stop true labor
- Irregular
- No change in contraction characteristics
- No show
- No cervical change
- Head may be ballotable
- Sedation stops false labor

# Reproductive tract (2)

- ***Cervix and vulva — Chadwick's sign***

congestion of the pelvic vasculature, cause bluish or purplish discoloration of the cervix and vulva

- ***Leukorrhoea:*** increase in vaginal discharge, rich in glucose, lactic acid, low vaginal pH. The increase of vaginal discharge consists of epithelial cells and cervical mucus due to hormonal stimulation.

Cervical mucus that has been spread on a glass slide and allowed to dry no longer forms a fernlike pattern but has a granular appearance.



# Breasts: increase in circulation

- **Engorgement and venous prominence**
- **Mastodynia (breast tenderness):** tingling to frank pain caused by hormonal responses of the mammary ducts and alveolar system
- **Montgomery's tubercles:** enlargement of circumlacteal sebaceous glands of the areola
- **Colostrum secretion:**
  - Circulatory increases result in breast engorgement and venous prominence. Similar tenderness may occur just before menses.
- Montgomery's tubercles: sometimes called montgomery's follicles, the small elevations surrounding the areolae, enlarge and become more prominent. enlargement of these glands occurs at 6-8 weeks and is due to hormonal stimulation.
- Colostrum: during the latter portion of pregnancy, a thick yellow fluid can be expressed from the nipples. Ultimately, lactation depends on synergistic actions of estrogen, progesterone, prolactin, hPL, cortisol and insulin.

# Appearance of Montgomery tubercle in the areola

- dilated sebaceous glands



# Cardiovascular change

- As the uterus enlarges and the diaphragm becomes elevated, the heart is displaced upward and somewhat to the left with rotation on its long axis, so that the apex beat is moved laterally to the left.
- With the anatomical changes in the heart, there may also be alterations in heart rhythm and electrocardiographic finding, and non pathologic murmurs may occur. ECG changes are probably due to the change in position of the heart and may include a 15-20 degree shift to the left in the electrical axis. There may be reversible ST, T and Q waves changes.
- In order to detect pathologic changes in the ECG, one has to know about physiologic changes during pregnancy. Diaphragmatic elevation causes leftward deviation of the heart. The result is a 15 degree left axis deviation. Q wave may be present in leads III and AVF. Inverted T waves may be seen in lead III. Unspecific ST changes may occur. Caused by the leftward deviation, the heart may appear enlarged in the chest roentgenogram.

# Cardiovascular changes (1)

- Position and size of heart
- ECG changes
  - Increased heart rate (+15%)
  - 15-degree left axis deviation
  - Inverted T-waves in lead III
  - Q in lead III and AVF
  - Unspecific ST changes
- Appear larger on roentgenogram

# Cardiovascular changes (2)

- Heart rhythms and murmurs: soft , transient

**Caution: How to interpret these murmurs**

- ***Inferior vena cava syndrome:***

In the supine position, the inferior vena cava is compressed by the enlarged uterus, resulting in decreased cardiac output. Some women may have symptoms that include dizziness, light-headedness, and syncope.

# Cardiovascular changes (3)

- Stroke volume +30%
- Heart rate +15%
- Cardiac output +40%
- Oxygen consumption +20%
- SVR (systemic vascular resistance) -5%
- Systolic BP -10mmHg
- Diastolic BP -15mmHg
- Mean BP -15mmHg

- Increases in stroke volume and heart rate are responsible for the changes in cardiac output. Increased metabolic demands of mother and fetus are the cause for this rise in cardiac output. The resting oxygen consumption of the parturient increases approximately 20% compared to non-pregnant levels. Increased hormonal levels, estrogen and prostaglandins cause a vasodilatation and therefore a decrease in systemic vascular resistance and pulmonary vascular resistance. Decreased peripheral resistance causes a small decrease in systolic blood pressure and a more marked decrease in diastolic blood pressure.

# Cardiovascular changes (4)

- Blood volume +30%
- Plasma volume +40%
- Red blood cell volume +20%
- Dilutional anemia

Increase cardiac output

Decrease blood viscosity

Vasodilatation

Right shift oxyhemoglobin dissociation curve



- Maternal blood volume increases during pregnancy, reaching a maximum of 30% at approximately 28-32 weeks of gestation. Plasma volume increases from 40-70 ml/kg which represents a rise of 40%. The different rate of increase in blood and plasma volume accounts for the relative anemia of pregnancy. The dilutional anemia of the parturient decreases the oxygen carrying capacity of the blood. Several mechanisms compensate for this disadvantage: increased cardiac output, decreased blood viscosity, vasodilatation and right shift of the oxyhemoglobin dissociation curve provide increased flow and better oxygen extraction in the tissue.
- Cardiac output begins a progressive rise in the first trimester and peaks by 22-28 weeks of gestation. The rise represents the increased metabolic demands of the mother and fetus as pregnancy progresses.

- Further, plasma osmotic pressure decreases during pregnancy, while oncotic pressure (colloid osmotic pressure) is reduced. Plasma oncotic pressure is mainly determined by albumin concentration, and this decreases by about 20 per cent during normal pregnancy to levels (28–37 g/L) that are considered abnormal outside pregnancy. As plasma oncotic pressure partly determines the degree to which fluid passes into and out of capillaries, its decrease is one of the factors responsible for the increase in glomerular filtration rate (GFR) during pregnancy and probably contributes to the development of peripheral oedema,

# Cardiovascular changes(5)

- ***Venous pressure:***

1. unchanged in the upper body
2. Significantly increases in the lower extremities, esp. during supine, sitting or standing position, returns to near normal in lateral recumbent position

# Hematologic system (1)

- Blood volume (polymorphonuclear) +40%
- Dilutional anemia                      Hb 11 g/L
- Leukocytosis                              15,000/ $\mu$ l
- Platelet                                      not change
- Sedimentation rate                      increase, 100m/h

- Hypervolemia begins in the first trimester, increases rapidly in the second trimester and plateaus at about the 30<sup>th</sup> week.
- The total blood leukocyte count increases during normal pregnancy from a prepregnancy level of 43-4500/ul to 5000-12000/ul in the last trimester. The cause of the rise in the leukocyte count, which primarily involves the polymorphonuclear, has not been established, although it seems likely to be caused by increased demargination of white cells. the increase starts from 7-8 weeks of gestation and peaked at 30 weeks.
- Some studies have reported an apparent increase in the production of platelets (thrombocytopoiesis) during pregnancy that is accompanied by progressive platelet consumption.

# Hematologic system (2)

- ***Clotting factors: hypercoagulable, throboembolism***

Fibrinogen (factor I)	+50%	(4.5 vs 3 g/L)
Factor VIII		increase
Factors VII, IX, X and XII		increase
Prothrombin time, PT		shortened
ATPP activated partial thromoplastin time		shortened
Fibrinolytic activity		decrease

- Pregnancy is considered a hypercoagulable state with an increased risk of venous thromboembolism both during pregnancy and the puerperium. The fibrinolytic activity is depressed. The risk of thromboembolism is approximately 2 times normal during pregnancy and increases to 5.5 times normal during the puerperium.

# Hematologic system (3)

## ■ Iron : active transplacental transfer

Requirement	1000mg
increase maternal red cell mass	500mg
fetal development	300mg
compensate for normal iron loss	200mg

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To supply, 300 mg of ferrous sulfate is needed, and twice the dose for anemic patients.



# Renal changes (1)

- Kidney slightly enlarged
- Renal plasma flow +35%
- Glomerular filtration rate +50%
- Serum creatinine, uric acid and urea nitrogen ↓
- Renin, angiotensin I and II ↑
- Renin substrate ↑
- Glucosuria (50%) +



# Maternal Physiology in Pregnancy: Urinary System

## ■ Anatomic Changes

- Renal hypertrophy
- Dilatation renal pelvis/calyces 15mm on the right in 3<sup>rd</sup> trimester 5mm on the left.
- Each kidney increases in length by 1-1.5cm, with a concomitant increase in weight.
- The ureters are dilated to 2 cm resulting in hydroureter from:
  - progesterone-induced smooth muscle relaxation causing hypotonia
  - mechanical compression above the brim of the bony pelvis by the ovarian vein complex in the suspensory ligament of the ovary
  - dextorotation of the uterus during pregnancy, may explain why the right ureter is usually more dilated than the left.

# Renal changes (2)

- |                             |            |
|-----------------------------|------------|
| ■ renal pelvis              | dilated    |
| ■ Ureters (esp. right side) | dilated    |
| ■ Bladder tone              | reduced    |
| ■ Bladder capacity          | reduced    |
| ■ Residual volume           | increased  |
| ■ Chance of pyelonephritis  | increaased |

- Increased residual volume and with the dilated collecting system that caused by hormonal effect mainly progesteron, urinary stasis results, predispose to an increased incidence of pyelonephritis in patients with asymptomatic bacteriuria.

# Pulmonary changes

- Mucosal hyperemia
- Subcostal angle
- Chest circumference and diameter
- Diaphragmatic excursion
- Tidal volume +30-40%
- $PO_2$  is increased,  $PCO_2$  is decreased.
- Total lung capacity decrease -15%
- Minute ventilation +30-40%
- Mild respiratory alkalosis

# Gastrointestinal change

- Morning sickness
  - ***hyperremesis gravidarum*** (weight loss, ketonemia and electrolyte imbalance)
- Dietary craving: pica
- Decreased gastrointestinal motility: reflux and heartburn
- Gallbladder function, cholestasis
- Hyperemia and softening of the gums (epulis)
- Hemorrhoid
- Appendix displaced

- The exact etiology of this nausea is unknown, the morning sickness appears related to elevated levels of progesterone, human chorionic gonadotropin, and relaxation of the smooth muscle of the stomach.
- In general, there is decreased gastrointestinal motility during pregnancy because of increasing levels of progesterone. As a result, gastric emptying time is prolonged and there is decreased esophageal tone and incompetence of the esophageal tone and incompetence of the esophageal-stomach sphincter, leading to gastric reflux and heart burn, common complaints in pregnancy.



# Skin changes

- Vascular spiders
- Striae gravidarum
- Hyperpigmentation (estrogen and melanocyte-stimulating hormone)
- Linea alba——linea nigra
- Chloasma
- Skin nevi



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# Metabolism

■ Basal metabolism rate, BMR	+15-20%
■ Weight gain	12.5
Fetus	3400g
Placenta	650
Amniotic	800
Uterus	960
Plasma, red cells	1450
Mammary glands	405
Extracellular, extravascular water	1480
Deposition of fat and protein	3345
■ Insulin resistance	

1. Fetal membrane is composed of \_\_\_\_\_ and \_\_\_\_\_.
2. The prerequisites for successful implantation are \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
3. Placenta is composed of \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
4. Maternal-fetal-placenta unit is a concept usually used to describe the production of \_\_\_\_\_ and can be used to evaluate the placental function.

# True or false

1. Supplement of iron during pregnancy is primarily to prevent fetal anemia.
2. Because of the frequent incidence of glucosuria among pregnant patients, quantitative urine glucose measurements are not clinically useful in managing patients with diabetes, because they do not reflect blood glucose levels.
3. The left pyelonephritis has a higher incidence in pregnant women.

4. On chest x-ray, the heart appears to demonstrate cardiomegaly during pregnancy.

5. In the fetus, the blood circulating in the IVC enters the right atrium and mix well with the deoxygenated blood from SVC and then goes to the left atrium and supplies the head, etc.