

Obstetrics & Gynecology TEAM



Physiological Changes in Pregnancy

Leader: Sara Alhaddab

Done By: Sara Alhaddab

◆ very important ◆ mentioned by doctor ◆ team notes ◆ not important

PHYSIOLOGICAL CHANGES IN PREGNANCY

■ Volume Homeostasis

○ The factors contributing to fluid retention are:

1. Sodium retention > fluid retention > edematous pregnant lady (physiological not pathological because not associated with high BP nor proteinuria)
2. Resetting of osmostat
3. Decrease in thirst threshold
4. Decrease in plasma oncotic pressure

○ Consequences of fluid retention are

1. ☛ Haemoglobin concentration falls (that's why in pregnancy we see "physiological anemia" due to the increase in plasma volume being more than that of hemoglobin and RBCs)
2. Haematocrit falls
3. Serum albumin concentration falls that's why the resetting osmolarity will change thus fluid retention
4. Stroke volume increases which also contributes to the fluid retention
5. Renal blood flow increases that's why pregnant women have to urinate a lot!

○ Decreases in:

1. Red cell count
2. Haemoglobin concentration
3. Haematocrit
4. Plasma folate concentration

All decrease as the plasma volume increases

○ Increases in:

1. white cell count in pregnancy it's ok to have slight increase of WBCs count and that doesn't mean infection.
2. erythrocyte sedimentation rate
3. fibrinogen

That's why pregnant women are susceptible to have DVTs.

■ Cardiovascular System

○ Normal changes in heart sounds during pregnancy:

1. Increased loudness of both s1 and s2 *
2. Increased splitting of mitral and tricuspid components of s1
3. No constant changes in s2
4. Loud s3 by 20 weeks' gestation
5. <5% with s4
6. >95% develop systolic murmur which disappears after delivery *
7. 20% have a transient diastolic murmur *
8. 10% develop continuous murmurs due to increased mammary blood flow * that's why you should continue on observing the lady after delivery.

Here you **don't** have to memorize any number you only have to know that there is increased loudness of cardiac sounds and that >95% of pregnant women develop systolic murmur which's physiological but should be observed after the delivery to make sure it was physiological.

- **Cardiovascular Changes**

1. Heart rate increases (10-20%) *that's why they have tachycardia*
2. Stroke volume increases (10%)
3. Cardiac output increases (30-50%) *as a consequence of the increase of both HR & SV*
4. Mean arterial pressure decreases (10%) *to allow the blood to flow easily into the placenta*
5. Peripheral resistance decreases (35%) *if it didn't decrease, the BP would increase and the blood flow to the fetus will be resisted reducing the blood going to the placenta.*

- **REPRODUCTIVE ORGANS**

- The Uterus
- The Cervix

Will be discussed later.

- **BREASTS AND LACTATION**

- **THE URINARY TRACT AND RENAL FUNCTION**

- **Renal changes**

1. Blood flow increases (60-75%)
2. Glomerular filtration increases (50%)
3. Clearance of most substances is enhanced
4. Plasma creatinine, urea and urate are reduced
5. Glycosuria is **normal** (*physiological*) but if recurrent and in each visit the lady has glycosuria, you should investigate her for diabetes.

- **ENDOCRINE GLANDS**

There is a physiological enlargement of the pituitary gland, that's why when the lady during delivery has PPH there will be relative ischemia to the pituitary gland (Sheehan's Syndrome)

- **Pituitary gland**

1. FSH and LH ↓ *normal decrease due to the –ve feedback by the high percentages of estrogen and progesterone.*
2. ACTH, Thyrotrophin, melanocyte hormone and prolactin ↑ *that's why melanocyte stimulating hormone increase and the pregnant women have hyperpigmentation of the neck and linea nigra.*
3. Prolactin level ↑ until the 30th week of pregnancy then more slowly to term. *To prepare the breasts for lactation, will increase steadily until the 30th week then will plateau.*

- **Adrenal gland**

1. Total corticosteroids ↑ progressively to term. *Due to the increase in ACTH*
2. This will ↑ the tendency of pregnant women to develop abdominal strine, glycosuria and hypertension

- **Thyroid gland**

That's why you can't investigate a women's thyroid during pregnancy, there will be overlap between the symptoms of hyperthyroidism and that of pregnancy .

1. Enlarges during pregnancy, occasionally to twice its normal size. This is mainly due to colloid deposition caused by a lower plasma level of iodine, consequent on the increased ability of the kidneys to excrete during pregnancy.
2. Oestrogen stimulates or increased secretion of thyroxin in binding globulin.
3. Both T3 and T4 levels rise. This rise will not indicate hyperthyroidism

- **GENETAL TRACT CHANGES**

- **UTERUS**

1. Uterine muscles grow to 15 times than pre-pregnancy length.
2. Uterine weight increases from 50 g before pregnancy to 950 g at term.
3. In the early weeks of pregnancy the growth is by hyperplasia and more partially by hypertrophy of the muscle fibres.
4. By 20 weeks growth ceases and the uterus expands by distension.
5. The uterine blood vessels also undergo hypertrophy and become increasingly coiled in the first half of pregnancy but no further growth after that.
6. The lower uterine segment is that part of the lower uterus and upper cervix lying between the line of attachment of the peritoneum of the utero vesical pouch superiorly and the histological internal os inferiorly. **Which is the part of the uterus which we'll cut through in case of caesarean section.**

- **THE CERVIX**

1. Becomes softer and swollen in pregnancy, with the result that columnar epithelium lining the cervical canal becomes exposed to the vaginal secretions **due to collagen changes**
2. Prostaglandins act on the collagen fibres, especially in the last week of pregnancy. At the same time collagenase is released from leucocytes, which also helps in breaking down collagen. The cervix becomes softer and more easily dilatable the so called ripening of the cervix.

- **VAGINA**

1. The vaginal mucosa becomes thickens, the vaginal muscle hypertrophies.
2. There is alteration in the composition of the connective tissue, with the result that the vagina dilates more easily to accommodate the fetus during parturition.
3. Oestrogen → desquamation of the superficial vaginal mucosal cells with ↑ in vaginal discharge when pathogenesis enters the vagina (**CANDIDA**, trichomonas) they will flourish rapidly.

*****mcq*** What's the most common vaginal infection in pregnancy? CANDIDA**

The surface of the cervix in case of no pregnancy is covered by stratified squamous externally, and columnar epithelium internally. In pregnancy however, there will be overgrowth of the columnar epithelium covering up the external squamous epithelium, that's why pregnant ladies complain of redness in the cervix thinking it might be ulcers or so.

■ ALIMENTARY SYSTEM CHANGES:

TRICKY POINT !!

The regurgitation is due to the relaxation of the sphincter NOT due to increase of acidity! In fact the acidity is reduced!!

1. The mouth and the gum become spongy because of intracellular fluid retention (prophylactic effect).
2. The lower oesophageal sphincter is **relaxed** which may permit regurgitation of gastric contents and cause heart burn.
3. Gastric secretion is **reduced** and food remains **longer** in the stomach.
4. The intestinal musculature is relaxed with **lower** motility → greater absorption and constipation.

****mcq****The time of emptying of the stomach in pregnancy is ...? INCREASED

- All the changes in the alimentary system are to increase the digestion time.
- Very important to consider especially in anesthesia for appendectomy, cesarean section or for any reason, because if you anesthetized a lady with her stomach full she might vomit and get aspiration pneumonia.

■ RENAL SYSTEM

1. The smooth muscle of the renal pelvis and ureters **relaxes**, causing their **dilatation**. This increases the capacity of the renal pelvis and ureters from 12 ml to 75 ml **allowing chance for urinary stasis** and ↑ the chances of urinary **infection**. **That's why MSU is a routine investigation for every pregnant woman, even with no symptoms because she might have asymptomatic bacteriuria.**
2. Urinary tract infection is more common in pregnancy. The muscles of the internal urethral sphincter relax and this together with the pressure of the uterus → degree of **incontinence**
3. The renal blood flow **increases** to the 16th week of pregnancy and then levels off.
4. GFR **increases** by 60% in early pregnancy and remains at the new level until the last 4 weeks of pregnancy when it falls.
5. Tubular reabsorption is unaltered.
6. **Clearance** of many solutes ↑ **like urea and creatinine**
7. Up to 300 mg of protein may be excreted in 24 hours. If >300 + high BP + edematous >>> **might be pregnancy induced hypertension with proteinuria**
8. ↑ GFR + progesterone effect → loss of Na.

■ IMMUNE SYSTEM CHANGES

1. HCG → ↓ **immune** response to pregnancy **otherwise the mother's body will reject the baby, and also one of the main causes of recurrent miscarriages is no reduction in the immunity of the mother.**
2. IgG, IgA and IgM ↓ from 10th week of pregnancy reaching their lowest level at 30 weeks and remain so till the end of pregnancy → ↑ risk of **infection** in pregnant women.

■ **WEIGHT GAIN IN PREGNANCY**

○ Healthy women will gain around **12 kg** of which **9 kg is gained in the last 20 weeks.**

○ The elements of weight gain:

| | | |
|-----------------|---------|----|
| - Fetus | 3300 | gm |
| - Placenta | 600 | gm |
| - Uterus | 900-950 | gm |
| - Breasts | 400 | gm |
| - Blood | 1200 | ml |
| - Fat Deposited | 2500 | |
| - Fluid | 2600 | |

The numbers are just for you to know, no need to memorize anything 😊

SUMMARY #1: What the doctor said at the end:

1. Increase in SV, HR, COP, plasma volume, renal blood flow, GFR, gastric emptying time, fibrinogen, UTI infection (especially candida).
2. Decrease in hemoglobin concentration, acidity, immunity, urea, creatinine.

SUMMARY #2: Kaplan:

PHYSIOLOGIC CHANGES IN PREGNANCY

A. Skin

Striae gravidarum-"**Stretch marks**" that develop in genetically predisposed women on the abdomen and buttocks.

Spider angiomata and palmer erythema-From increased skin vascularity.

Chadwick sign-Bluish or purplish discoloration of the vagina and cervix as a result of increased vascularity.

Linea nigra-Increased pigmentation of the lower abdominal midline from the pubis to the umbilicus.

Chloasma-Blotchy pigmentation of the nose and face.

B. Cardiovascular

Arterial blood pressure-Systolic and diastolic values both decline early in the first trimester, reaching a nadir by 24-28 weeks, then they gradually rise toward term but never return quite to prepregnancy baseline. Diastolic falls more than systolic, as much as 15 mm Hg.

Arterial blood pressure is never normally elevated in pregnancy.

Venous blood pressure-Central venous pressure (CVP) is unchanged with pregnancy, but femoral venous pressure (FVP) increases two- to threefold by 30 weeks' gestation.

Plasma volume-Plasma volume increases up to 50% with a significant increase by the first trimester. Maximum increase is by 30 weeks. This increase is even greater with multiple fetuses.

Systemic vascular resistance (SVR)-SVR equals blood pressure (BP) divided by cardiac output (CO). Because BP decreases and CO increases, SVR declines by 30%, reaching its nadir by 20 weeks. This enhances uteroplacental perfusion.

Cardiac output (CO)-CO increases up to 50% with the major increase by 20 weeks. CO is the product of heart rate (HR) and stroke volume (SV), and both increase in pregnancy. HR increases by 20 beats/min by the third trimester. SV increases by 30% by the end of the first trimester. CO is dependent on maternal position. CO is the lowest in the supine position because of inferior vena cava compression resulting in decreased cardiac return. CO is the highest in the left lateral position. CO increases progressively through the three stages of labor.

Murmurs-A systolic ejection murmur along the left sternal border is normal in pregnancy owing to increased CO passing through the aortic and pulmonary valves. Diastolic murmurs are never normal in pregnancy and must be investigated.

Table 1-2. Cardiovascular Changes

| | | |
|---------------------------------------|-----------|-----------|
| Arterial blood pressure | Systolic | ↓ |
| | Diastolic | ↓↓ |
| Venous pressure | Central | Unchanged |
| | Femoral | ↑ |
| Peripheral vascular resistance | | ↓ |

C. Hematologic

Red blood cells (RBC)-RBC mass increases by 30% in pregnancy; thus, oxygen-carrying capacity increases. However, because plasma volume increases by 50%, the calculated hemoglobin and hematocrit values decrease by 15%. The nadir of the hemoglobin value is at 28-30 weeks' gestation. This is a physiologic dilutional effect, not a manifestation of anemia.

White blood cells (WBC)-WBC count increases progressively during pregnancy with a mean value of up to 16,000/mm³ in the third trimester.

Erythrocyte sedimentation rate (ESR)-ESR increases in pregnancy because of the increase in gamma globulins.

Platelet count-Platelet count normal reference range is unchanged in pregnancy.

Coagulation factors-Factors VII, VIII, IX, and X increase progressively in pregnancy, leading to a hypercoagulable state.

D. Gastrointestinal ~

Stomach-Gastric motility decreases and emptying time increases from the progesterone effect on smooth muscle. This increase in stomach residual volume, along with upward displacement of intraabdominal contents by the gravid uterus, predisposes to aspiration pneumonia with general anesthesia at delivery. ~

Large bowel-Colonic motility decreases and transit time increases from the progesterone effect on smooth muscle. This predisposes to increased colonic fluid absorption resulting in constipation.

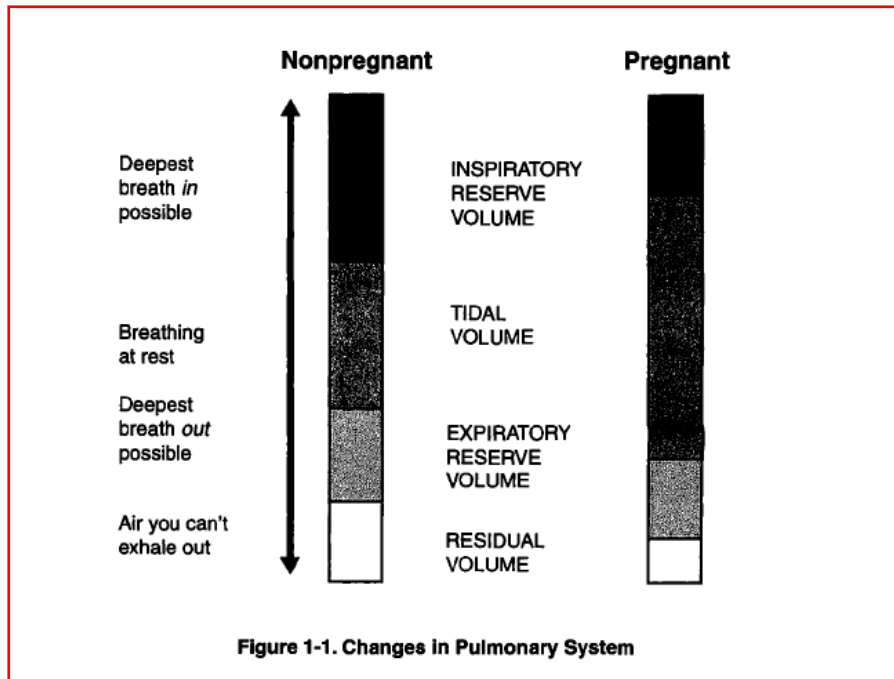
E. Pulmonary

Tidal volume (V_t)-V_t is volume of air that moves in and out of the lungs at rest. V_t increases with pregnancy to 40%. It is the only lung volume that does not decrease with pregnancy.

Minute ventilation ('V_e)-V_e increases up to 40% with the major increase by 20 weeks. V_e is the product of respiratory rate (RR) and V_t. RR remains unchanged with V_t increasing steadily throughout the pregnancy into the third trimester.

Residual volume (RV)-RV is the volume of air trapped in the lungs after deepest expiration. RV decreases up to 20% by the third trimester. To a great extent this is because of the upward displacement of intraabdominal contents against the diaphragm by the gravid uterus.

Blood gases--The rise in V_t produces a respiratory alkalosis with a decrease in P_{cO2} from 40 to 35 mm Hg and an increase in pH from 7.40 to 7.45. An increased renal loss of bicarbonate helps compensate, resulting in an alkalotic urine.



F. Renal

Kidneys-The kidneys increase in size because of the increase in renal blood flow. This hypertrophy doesn't reverse until 3 months postpartum.

Ureters-Ureteral diameter increases owing to the progesterone effect on smooth muscle. The right side dilates more than the left in 90% of patients.

Glomerular filtration rate (GFR)-GFR, renal plasma flow, and creatinine clearance all increase by 50% as early as the end of the first trimester. This results in a 25% decrease in serum blood urea nitrogen (BUN), creatinine, and uric acid.

Glucosuria-Urine glucose normally increases. Glucose is freely filtered and actively reabsorbed. However, the tubal reabsorption threshold falls from 195 to 155 mg/dL.

Proteinuria-Urine protein remains unchanged.

G. Endocrine

Pituitary-Pituitary size increases by 100% by term from increasing vascularity. This makes it susceptible to ischemic injury (Sheehan syndrome) from postpartum hypotension.

Adrenals-Adrenal gland size is unchanged, but production of cortisol increases two- to threefold.

Thyroid-Thyroid size increases 15% from increased vascularity. Thyroid binding globulin (TBG) increases, resulting in increased total T3 and T4, although free T3 and free T4 remain unchanged.

H. Fetal Circulation

Three in utero shunts exist within the fetus. The **ductus venosus** carries blood from the umbilical vein to the inferior vena cava. The **foramen ovale** carries blood from the right to the left atrium, and the **ductus arteriosus** shunts blood from the pulmonary artery to the descending aorta.