

PHYSIOLOGICAL CHANGES IN PREGNANCY

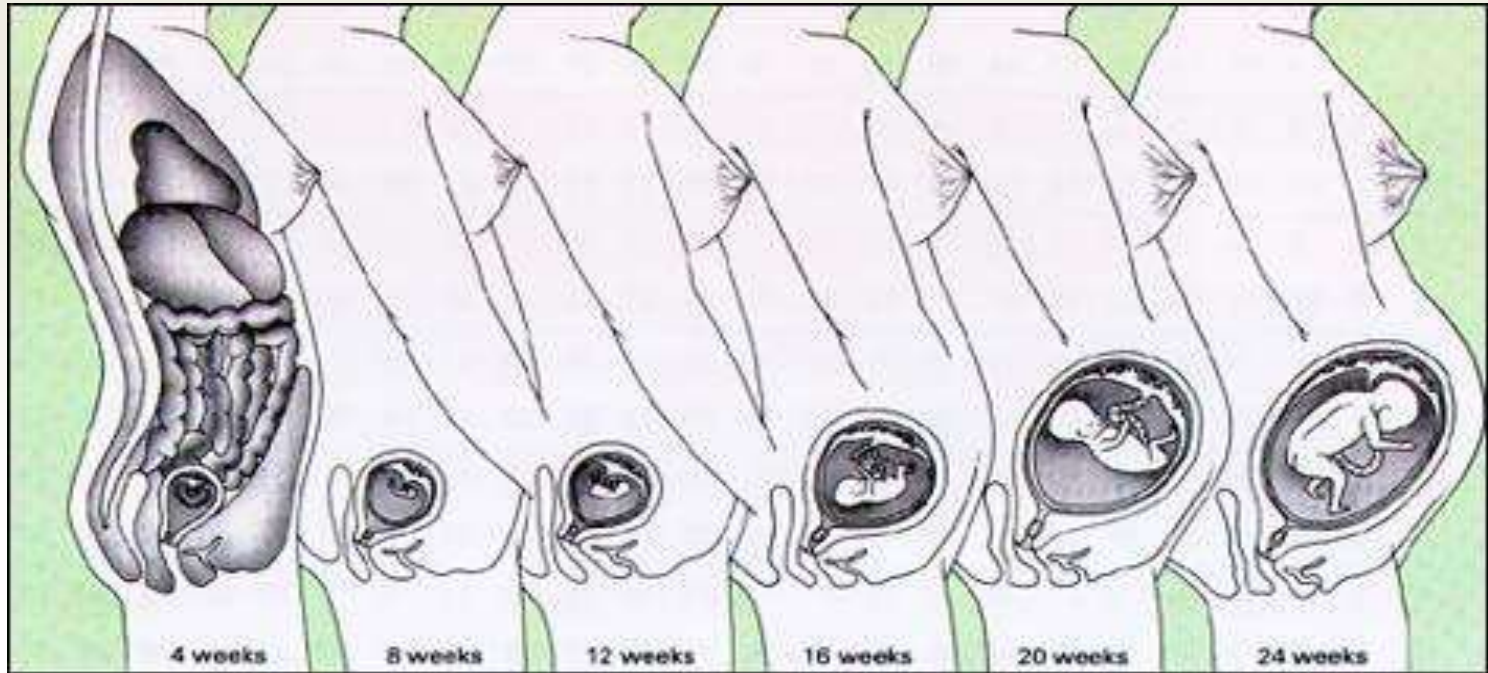
الطبيبة الأستشارية الأختصاص

الدكتورة

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The physiological changes of pregnancy are strongly proactive, not reactive, with the luteal phase of every ovulatory menstrual cycle ‘rehearsing’ for pregnancy. Most pregnancy-driven changes are qualitatively in place by the end of the first trimester, only maturing in magnitude thereafter.

Aim : to maximize nutrition and oxygen to the developing fetus and help the maternal system adjust to the extra stress.

Lack of appreciation of this difference may lead to inappropriate management of clinical problems in obstetric.

Maternal response to • pregnancy

**Normal pregnancy evokes a systemic •
inflammatory response, which includes the
endothelium. This may explain the greater
risk of cardiovascular disease in later life of
parous women in comparison with
nulliparous women. Markers of oxidative ‘
stress’ rise progressively throughout the**

The major maternal physiological adaptation to pregnancy

1-Systemic changes:

-volume homeostasis.

-blood

-cardio vascular system.

2-Respiratory changes.

3-urinary tract and renal function.

4-Alimentary tract

5-Immunological Changes

6-Reproductive organs.

7-endocrinological changes.

Systemic Changes

A. volume homeostasis:

- fluid retention is the most fundamental systemic changes of normal pregnancy.
- the total blood volume is increased during pregnancy 30%.
- the most marked expansion occurs in extra cellular volume (ECV) with some increase in intra cellular water.

Total body water

- Increases 6-8 L
- Increases by 40 %
- Normal body water
 - 2/3 intracellular
 - 1/3 extracellular
 - 3/4 interstitial
 - 1/4 intravascular
- 2/3 increase is extravascular

Haematology •

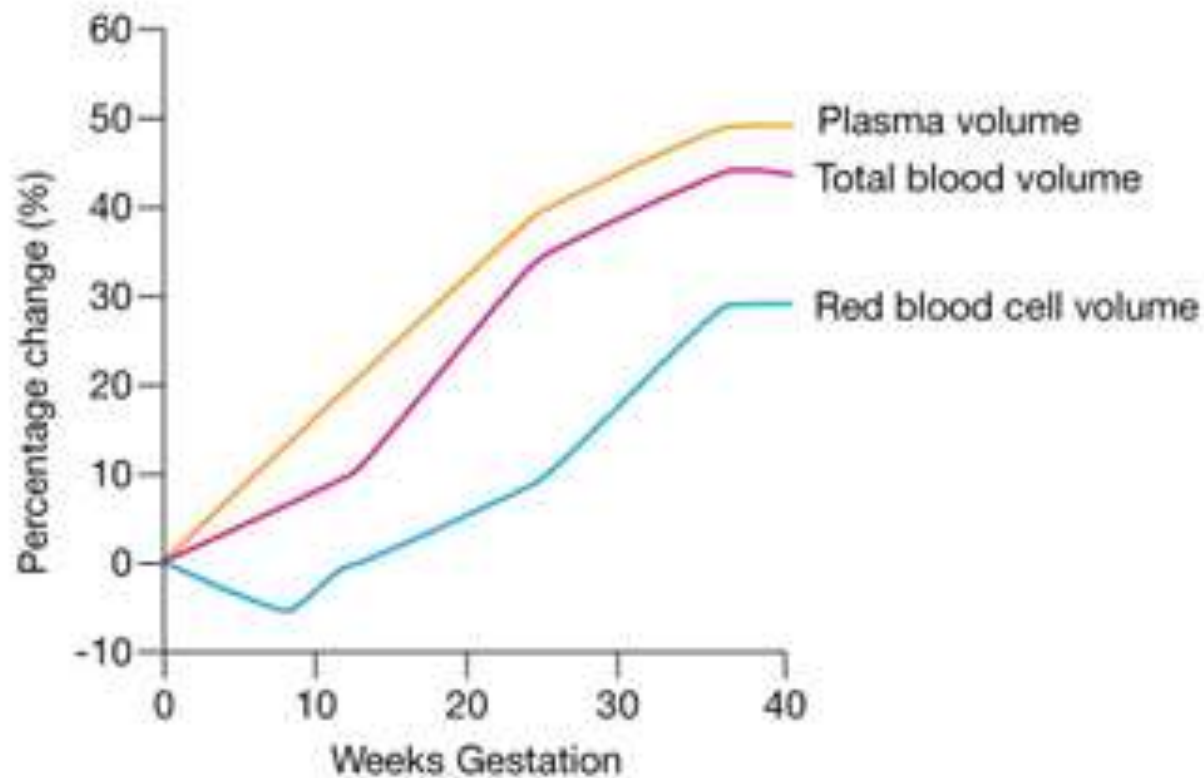
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The circulating red cell mass rises by 20 – 30% during pregnancy, with increases in both cell number and size. It rises more in women with multiple pregnancies, and substantially more with iron supplementation (~ 29% compared with 17%). Serum iron concentration falls, the absorption of iron from the gut rises and iron - binding capacity rises in a normal

Physiologic anemia of pregnancy

- Physiologic intravascular increase in plasma volume over RBC volume---- change
- Plasma volume increases 50-70 %
 - Beginning by the 6th wk
- RBC mass increases 20-35 %
 - Beginning by the 12th wk
- Disproportionat Hemodilution
- Despite erythrocyte production there is a physiologic fall in the hemoglobin and hematocrit readings

Maternal Intravascular Volume Changes



The factors contributing including:

- Increase sodium retention.
- Decrease in plasma osmotic pressure.
- Decrease in thirst threshold.
- Resetting of osmostat.
- Decrease in plasma oncotic pressure.

Blood: B

The marked increase in plasma volume associated with normal pregnancy causes dilution of many circulating factors.

Hematological changes

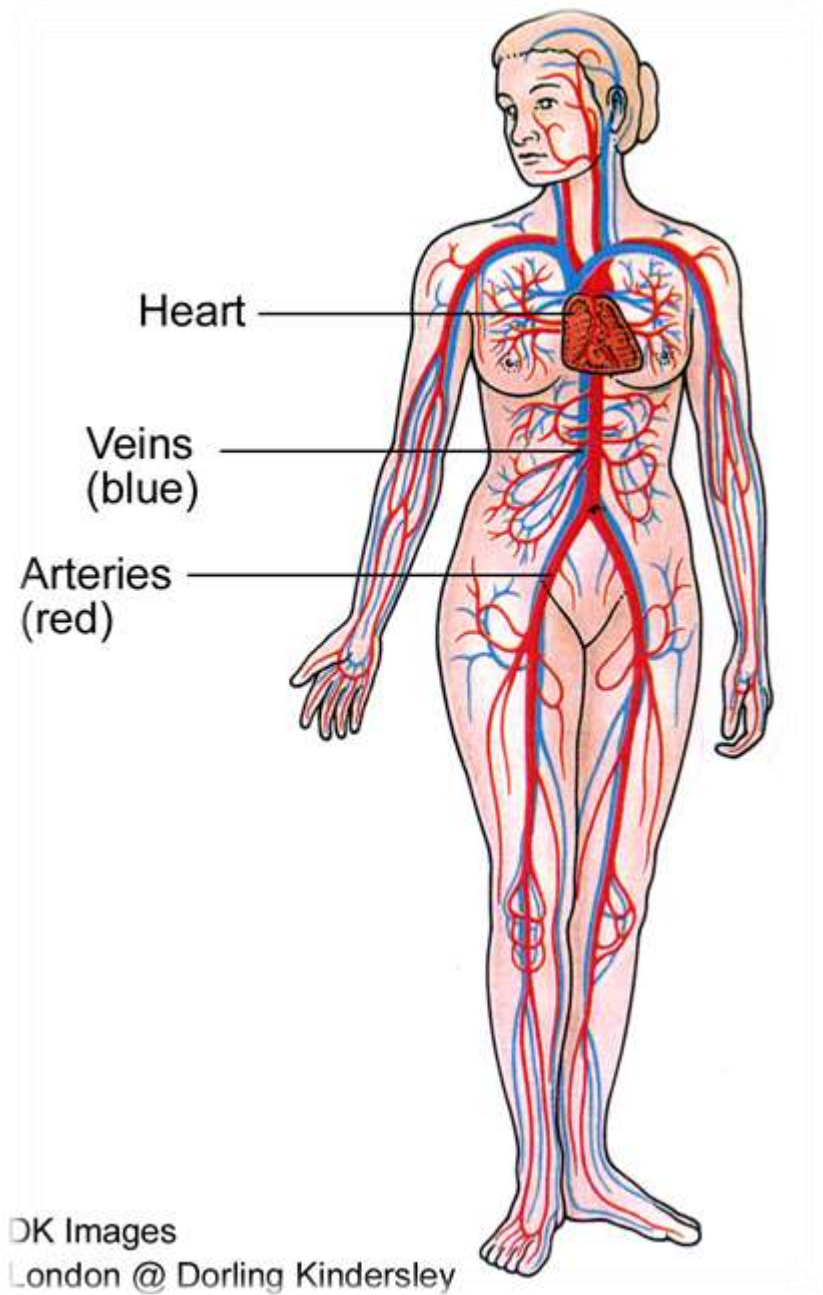
Decrease in:

- **red cell count.**
- **hemoglobin concentration.**
- **haematocrit.**
- **plasma folate concentration.**

Increase in:

- **white cell count.**
- **erythrocyte segmentation rate .**
- **fibrogen concentration.**

Circulatory system



The cardiovascular system •

• There is a significant fall in total peripheral resistance by 6 weeks' gestation to a nadir of about 40% by mid- gestation, resulting in a fall in afterload. This is 'perceived' as circulatory under filling, which activates the renin– angiotensin – aldosterone system and allows the necessary expansion of the plasma volume (PV) . By the late third trimester, the PV has increased from its baseline by about 50% in a first pregnancy and 60% in a second

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. There is probably a fall in baro reflex sensitivity as pregnancy progresses, and heart rate variability falls. Stroke volume rises a little later in the first trimester. These two factors push the cardiac output up by 35–40% in a first pregnancy, and by about 50% in later pregnancies; it can rise by a further third in labour) Measuring

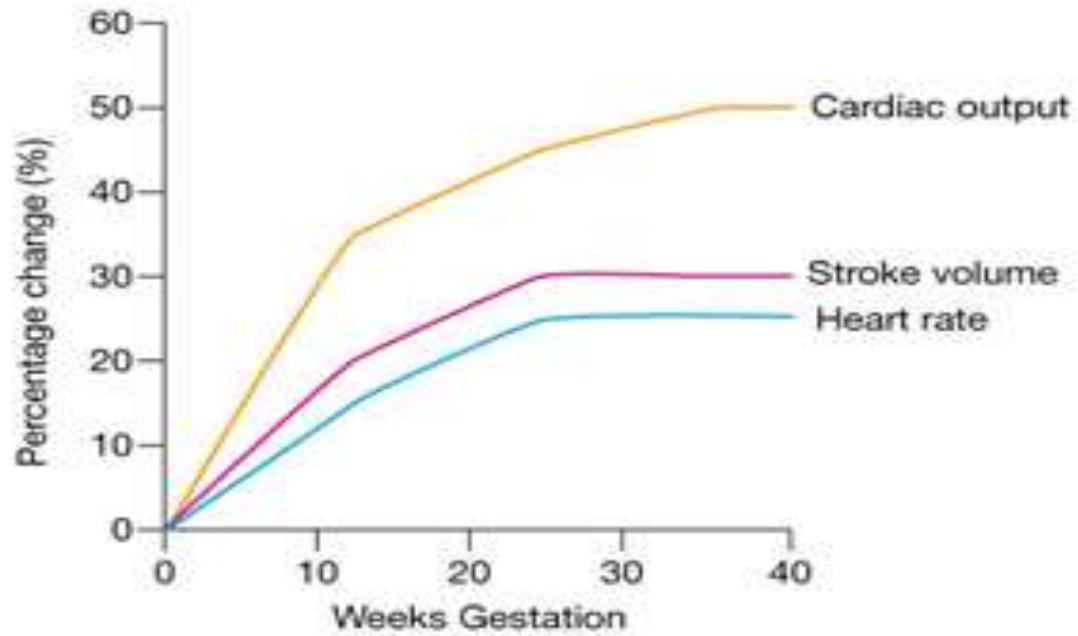
Cardio vascular changes: C

Earliest changes is peripheral vasodilatation

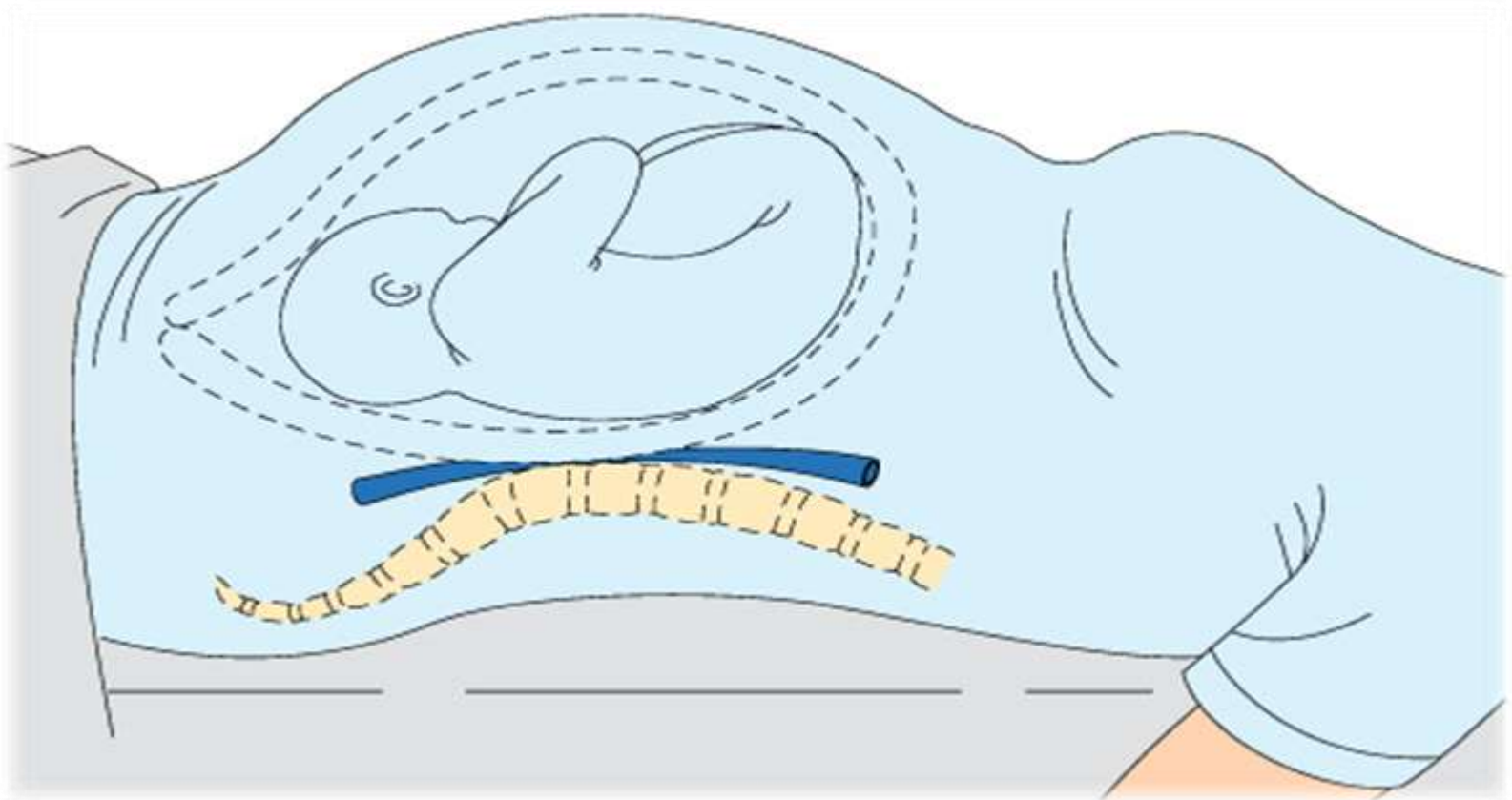
Results in decreased systemic vascular resistance →
↑CO 6 L/ min. Max. (22-28)wks.

- heart rate increase (10-20%).
- stroke volume increase (10%).
- cardiac out put increase (30-50%).
- Mean arterial blood pressure decrease (10%).-
- Peripheral resistance decrease (35%).-

Maternal Cardiovascular Changes



Supine hypotension related to Venal cava syndrome



normal changes in heart sounds during pregnancy

- increase loudness of both S1 & S2.
- >95% develop systolic murmur which disappears after delivery.
- 20% have a transient diastolic murmur.
- 10% develop continues murmur due to increase mammary blood flow.
- ectopics
- Relative tachy cardia
- collapsing pulse

The respiratory system

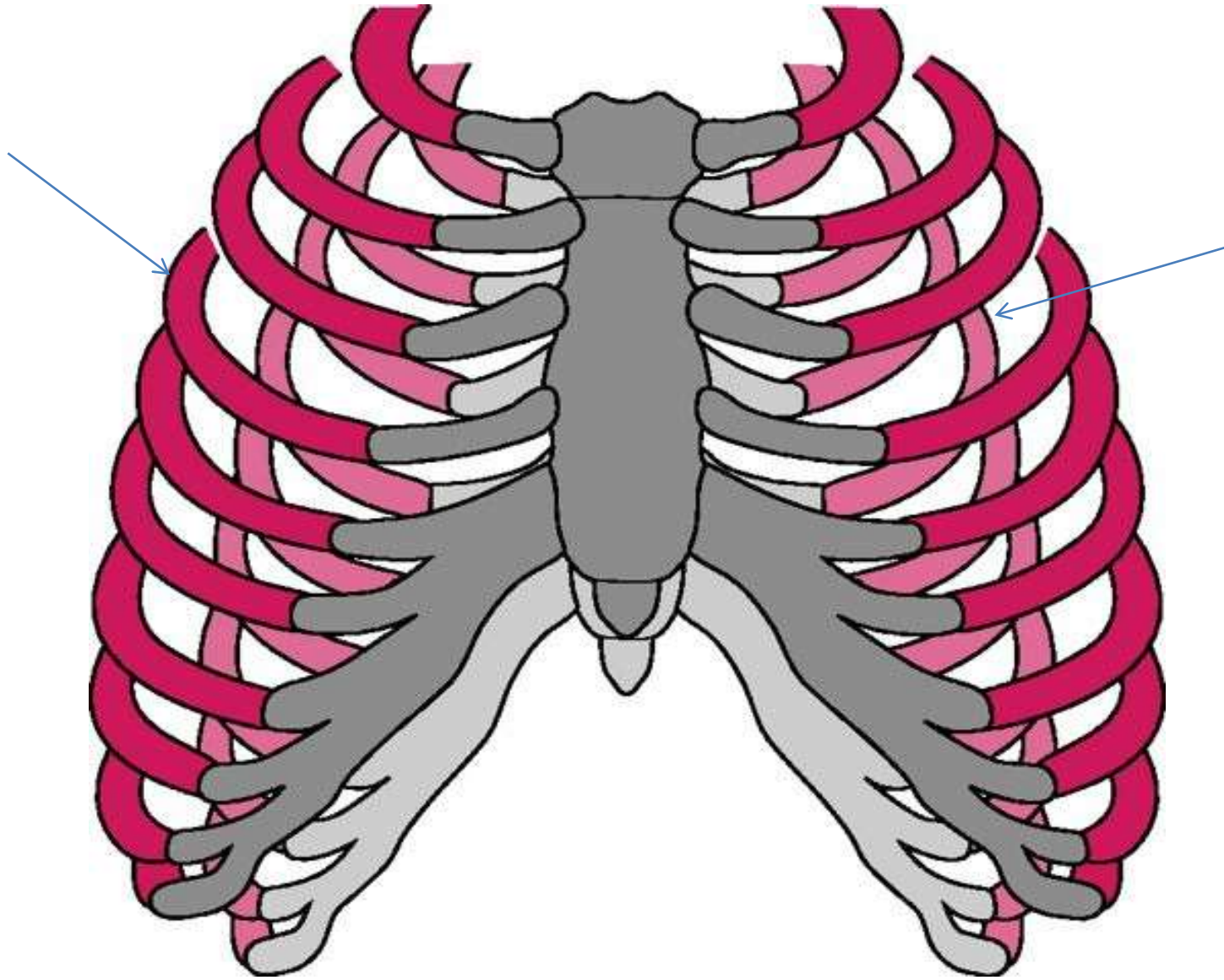
Tidal volume rises by about 30% in early pregnancy to 40 – 50% above non - pregnant values by term, with a fall in expiratory reserve and residual volume . Neither forced expiratory volume in 1 s (FEV 1) nor peak expiratory flow rate are affected by

Respiratory changes

- increase O₂ demand by 20 %.
- ↑tidal volume with normal respiratory rate.
- ↑pO₂ and ↓pCO₂ with compensatory ↓HCO₃⁻ (mild compensated respiratory alkalosis).
- Breathlessness due to hyperventilation and elevation of diaphragm.
- tissue and oxygen availability to placenta improves.
- PH alters little.

Ventilatory Changes:

- thoracic anatomy changes.
- tidal volume increases.
- vital capacity increase.
- functional residual capacity decrease.



The urinary tract and renal function

- blood flow increase (60-70%).
- glomerular filtration increased (50%).
- clearance of most substances is enhanced.
- plasma creatinine ,urea,urate are reduced.
- glycoseuria is normal.

Alimentary system changes

- ❑ the gums becomes spongy.
- ❑ the lower oesophageal sphincter is relaxed (hurt burn).
- ❑ gastric secretion is reduced.
- ❑ the intestinal musculature is relaxed (constipation).

- ❑ ♦ Hepatic function & hepatic blood flow → unchanged.
- ❑ ♦ Minor ↑ in Sr. Transaminases & LDH in 3rd trimester.
- ❑ ♦ ↑ Sr. Alkaline phosphatase (placental).
- ❑ ♦ Mild ↓ in Sr. albumin (dilutional).
- ❑ ♦ 25 – 30% ↓ in pseudo choline esterase activity.
- ❑ ♦ ↑ Progesterone levels → inhibit release of cholecystokinin → incomplete emptying of gall bladder → altered bile acid composition → formation of cholesterol stones.

Immunology •

•
Only two types of fetal tissue come into direct contact with maternal tissues: the villous trophoblast and the extravillous trophoblast. Villous trophoblast, which is a continuous syncytium, is bathed in maternal blood but seems to be immunologically inert and never expresses HLA class I or class II molecules. Extravillous trophoblast is directly in contact with maternal endometrial/decidual tissues and does not

Immunology

- Must adapt to accept ‘allograft’
- Immune response altered, but not deficient
- Modulates away from cell-mediated cytotoxic effects
 - Progesterone effect
 - NK cells decrease by 30%
 - Enhanced humoral / innate immunity
 - Immunoglobulins still active
 - IgG crosses placenta
 - More susceptible to CMV, HSV, Varicella, Malaria
 - **Decrease** in symptoms of some autoimmune disorders

Coagulation •

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**Continuing low - grade coagulopathy is a feature of normal pregnancy [15].
sedimentation rate rises early in pregnancy due to the increase in fibrinogen and other physiological**

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Reproductive organs

A. the uterus:

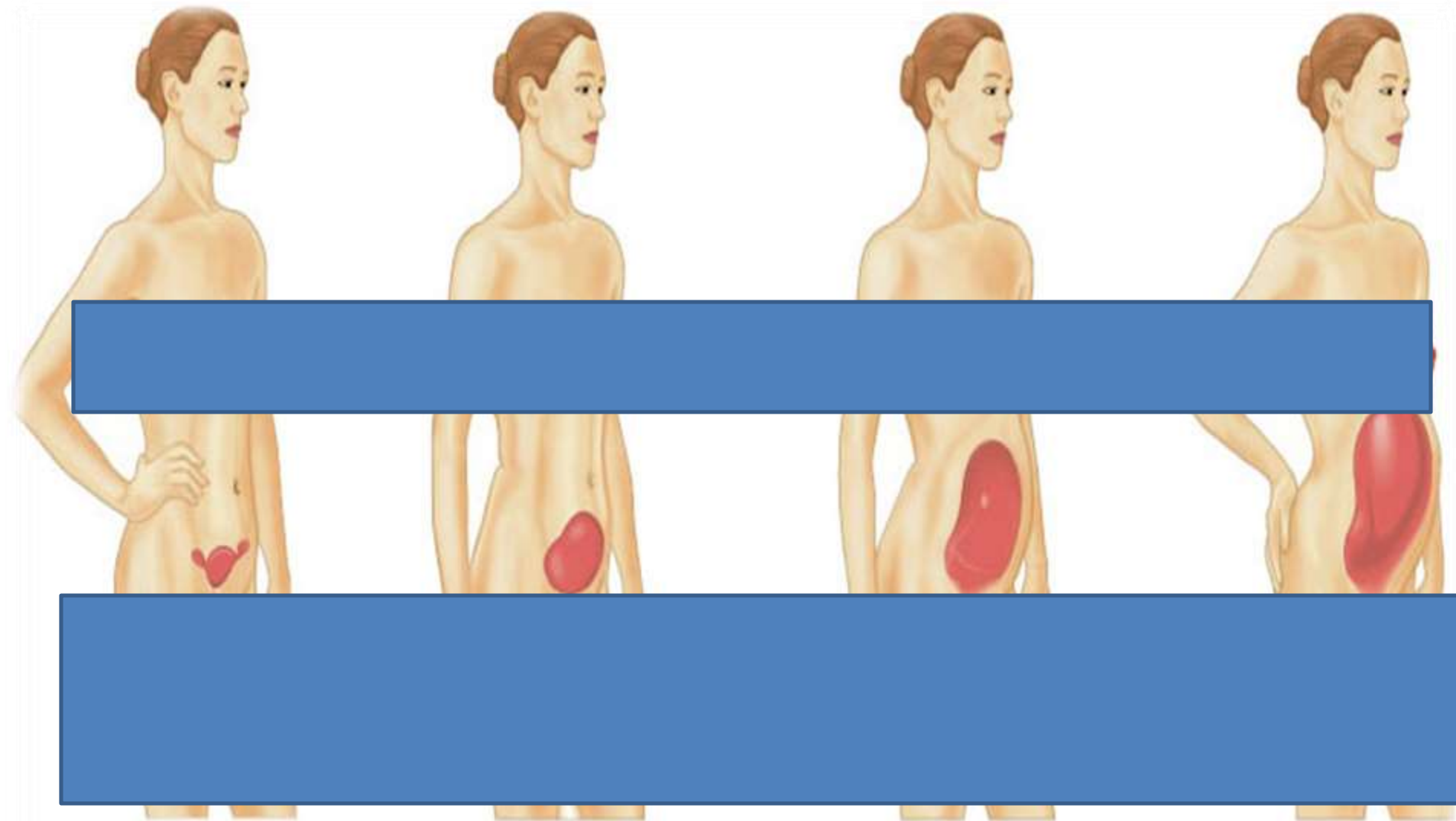
- ❑ the adult uterus comprising three layers:
- ❑ inner layer thin circular MF.
- ❑ outer layer thin long MF.
- ❑ central layer thick inter locking fiber.
- ❑ the ratio of muscle to connective tissue increase from the lower part of the uterus to the fundus.

The uterus •

The first - trimester human embryo appears to gain nutrients histiotrophically, from the endometrial glands. These glandular secretions are rich in carbohydrates, lipids and growth factors and can well support early growth while the conceptus is small] .

The outer third of the myometrium, as well as the endometrium, is anatomically changed by pregnancy, and once a pregnancy has gone beyond the first trimester, these changes

- ❑ in early pregnancy uterine growth result from both hyperplasia and hypertrophy while later hypertrophy accounts for most of increase.
- ❑ it weight one kilo gram at term(in pre pregnancy 50-60 grams
- ❑ as the pregnancy advanced the uterus divided into upper and lower uterine segment the lower uterine segment composed of lower part of uterus and the upper cervix composed mainly from connective tissue because of this the lower uterine segment becomes stretched in late pregnancy.



(a) Before conception

(b) 4 months

(c) 7 months

(d) 9 months

B.the cervix:

- the cervix becomes softer and swollen in pregnancy with the result columnar epithelium lining cervical canal becomes exposed to vaginal secretion.
- oestradiol stimulate growth of columnar epithelial of the cervical canal so it becomes violte and is called ectropine.
- the mucus gland becomes distended and secrete mucus which forms a mucus plug that is expelled in labour as the show.
- prostaglandins and collagenase especially in last weeks of pregnancy act on collagen fiber make cervix more softer.

C.the vagina :

- the vaginal mucosa becomes thicker during pregnancy.
- the vaginal discharge during pregnancy increased due to increase desquamation of the superficial vaginal mucosal cells

D-breasts and lactation :

- the earliest changes is a swelling of the breast tissue.
- oestrogen leads to increase in number of glandular ducts.
- progesterone leads to proliferation of glandular epithelium of the alveoli.
- prolactine leads to active secretion of milk after birth.

Endocrinological changes:

- prolactin concentration increases markedly but act after delivery.
- human growth hormone is suppressed .
- insulin resistance develop.
- thyroid function changes little.
- trans placental calcium transport is enhanced.
- corticosteroid concentration increased.
- aldosterone concentration increased.
- angiotensin and renin increased

Hormones produced within uterus

human chorionic gonadotrophin (HCG):

- it is secreted by trophoblast and can be detected in serum 10 days after conception (RIA).
- there is high level of circulating HCG in early pregnancy (to provide a suitable environment for implantation and development).
- to support corpus luteum secretion of oestrogen and progesterone in the first trimester until the placenta becomes able to produce these hormone.
- the peak level normally occur in the 12th week .

- **constant level of HCG in late pregnancy is useful in:**
 - ❑ **controlling placental secretion of Estrogen progesterone.**
 - ❑ **suppressing maternal immune system against fetus.**
- **the human chorionic gonadotrophine normally disappear from urine 7-10 days after delivery of placenta.**

Human Placental Lactogen

- it is secreted by syncytiotrophoblast.
- It is level increase when the level of HCG start to drop .
- HPL has no effect on fetus.
- HPL effect on :

1-the breast:

- o mammary growth during pregnancy.
- o produce of colostrums.
- o milk production lactation.

2-proteins:

- o HPL stimulate protein synthesis at cellular level.

3-carbohydrate:

- o stimulate insulin secretion .

- o inhibit insulin action.

4-fat:HPL mobilize fat from body store (lypolysis) lead to increase maternal blood glucose and maternal tissue can not utilize the glucose so the glucose will be available for fetus.

Estrogen

- it is produce by corpus luteum in early pregnancy.
- it is produce by placenta in late pregnancy.
- fetus (liver and adrenal) provide certain enzyme which are lack in placenta.

role of estrogen:

- ❑ On connective tissue: estrogen leads to polymerization of mucopoly saccarides of the ground substance leads to loose connective tissue mainly in the cervix.
- ❑ On the protein: estrogen stimulate directly RNA synthesis lead to protein synthesis.

progesterone

- it is production same as estrogen.
- it has effect on smooth muscle leads to decrease muscle excitability leads to muscle relaxation mainly in uterus.

Thyroid function

- increase thyroid binding globulin.
- increase bound form of T3,T4.
- no change in free form of T3,T4.

So no evidence to support what previously thought to be physiological such as increase in size of thyroid gland , increase BMR, body temperature, heart rate.

Skin Changes

- **Increased estrogen levels** may cause:
 - **hyper pigmentation** between the umbilicus and symphysis pubis , nipples(1st and 2nd areola, abdominal midline (linea Ingra) and mask face, which is butterfly pigmentation of the forehead, nose, upper lip and cheeks (chloasma gravid arum).
- **Hyper dynamic circulation and high levels of estrogen** may cause: spider naevi and **Stria gravid arum ("stretch marks")** due to:
 - over stretching of the skin, the elastic fibers may rupture together with small blood vessels, more marked below the umbilicus, on the breast, the palmer erythema.
- buttocks and thighs (appear in some women).
- **Falling of hairs and brittleness of nails** may occur during pregnancy.





Weight Gain in Pregnancy

- **Normal weight gain** is approximately 12.5kg (usually at a rate of 0.5kg per week for the last 20 weeks). 5kg is the fetus, placenta, membranes and amniotic fluid and the rest maternal stores of fat and protein and increased intra and extra-vascular volume.
- Daily energy requirements in pregnancy are increased to about 2000-2500calories per day.
- Associated with good outcome, i.e. delivery of normal sized baby
- Total pregnancy expenditure is 75,000kcalories.
- The basal metabolic rate increases by 15-20%.

Musculoskeletal Changes in Pregnancy

- **↑ levels of relaxin** may cause:
 - ↑ ligament laxity (↓ligamentous tensile strength, ↑mobility of structures supported by ligaments will contribute to:
 - back pain and pubic symphysis dysfunction, joint injury specially weight bearing joints of the back, pelvis, and lower extremities.
- **Shift in posture** with forward head, round shoulders, exaggerated lumbar lordosis, hyper-extended knees, and pronated feet.
- **Change of the center of gravity**, resulting in changes in balance.
- **Change of the length of muscles.**
- **Total calcium levels decreased** but ionized calcium levels normal
- **No loss of bone density** during pregnancy.
- In some pregnant women there is a **tendency of decalcification of bones and subluxation of joints** specially sacroiliac joint and symphysis pubis, leading waddling gait.

Diagnosis of pregnancy

- History: symptoms.
- Examination: signs.
- Investigation : pregnancy test and ultrasound.

symptoms of pregnancy

1-Amenorrhoea:

abrupt cessation of menses in a woman with regular cycle is highly suggestive.

2-breast symptoms:

tenderness and fullness may be noticed .

3-frequency of micturation :

pressure on the urinary bladder by enlarging uterus.

4-nausea with or without (morning sickness).

5-abdominal enlargement.

6-fetal movement:

☐ quickening is the first feels fetal movement PG
at (18-20wks).

☐ Multi para at (16-18wks).

signs of pregnancy

1-breasts signs:

- enlargement and increase pigmentation of the nipple.
 - increased pigmentation in the areola (areola).
- formation of secondary areola.
- montgomery areola or tubercle:
- small tubercles 12-20 at the periphery of primary areola appear at 8th week due to active sebaceous gland.
- prominent vein on the surface.
- colostrum at 16th week is reliable in primigravida.

2-skin signs:

- **linear nigra.**
- **stria gravidarum.**
- **chloasma.**

3-genital tract signs:

- **bluish discolouration of the vulva.**
- **genital tract becomes more soft and warm.**
- **Uterine changes:**
 - **uterus becomes abdominal organs at 12th week.**
 - **uterus becomes rounded (globular) instead of flatten in antero posterioly.**
 - **uterus becomes soft due to increase vascularity.**

4-signs due to presence of the fetus:

- fetal heart sounds:
- after 12 weeks fetal heart heard with fetal sonicaid.
- after 24th week fetal heart heard with fetal stethoscope.
- FHR 120-160 beats/minutes.
- funic soufflé: heard when fetal stethoscope lie directly over umbilical cord it is soft blowing murmur synchronous with fetal heart sounds.
- palpitation of fetal parts from 24th weeks.
- fetal movement: may felt during palpation.
- Braxton hicks sign: irregular painless contraction palpable at 20th week.

investigation

1-pregnancy tests:

- a pregnancy tests detects human chorionic gonadotrophine(HCG) in mother urine or serum.

urine tests: agglutination inhibition (day 35 after LNMP).

- standard HCG is adsorbed on particles or cells in suspension..
- anti serum (Ab) and some of patient urine is added.
- if urine contains HCG it will combine with the antibody and thus prevents it from binding and agglutinating the particles.

- **if urine containing no HCG anti body binds adjacent particles thus causing agglutination.**
- **the test can be carried out on slides or in tubes.**

blood tests (day 10 after implantation):

- **radio immune assay (RIA).**
- **Enzyme-linked immuno assay (Elisa):**
 - **Can detect levels as low as 0.1-0.3 iu/l**
 - **Can detect pregnancy before the patient missed period.**

Ultrasonography

- 4 weeks: pregnancy sac with decidual reaction
.
- 5 weeks: yolk sac.
- 6 weeks: fetal echo.
- 6-7 weeks : presence of fetal heart.
- 9 weeks :fetal morphology.

THANK YOU