King Saud University Medical City

Department of Obstetrics & Gynecology

Course 482

PHYSIOLOGICAL CHANGES IN PREGNANCY

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OBJECTIVES

- Symptoms and physical findings of each organ system
- Physiologic versus pathologic changes
- Diagnostic tests and interpretations during physiological changes

PHYSIOLOGICAL CHANGES IN PREGNANCY

- Hematological
- Cardiovascular
- Respiratory
- Renal
- Endocrine
- Gastrointestinal
- Dermatological
- MSK

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HEMATOLOGICAL CHANGES

- **Hypercoagulable**
  - Estrogen & Vascular stasis
  - Increased risk for thromboembolic disease
    - Increase in fibrinogen, **all** coag factors except II, V, XII
    - Fall in protein S and sensitivity to APC
- Fall in platelets and factor XI and XIII
- Increase in WBC

HEMATOLOGICAL CHANGES

- Hemoglobin stays the same (12-16 g/dL) initially
  - May drop down to 10 g/dL and still be normal physiologic anemia.
  - Normal pregnancy Hgb is 10-14 g/dL later in pregnancy
- Decreased Hct (38-47%)
  - Normal pregnancy Hct is 32-42 later in pregnancy

PHYSIOLOGIC ANEMIA OF PREGNANCY

- Plasma volume increases **50-70 %**
  - Beginning by the 6th wk
- RBC mass increases **20-35 %**
  - Beginning by the 12th wk

- Hemodilution

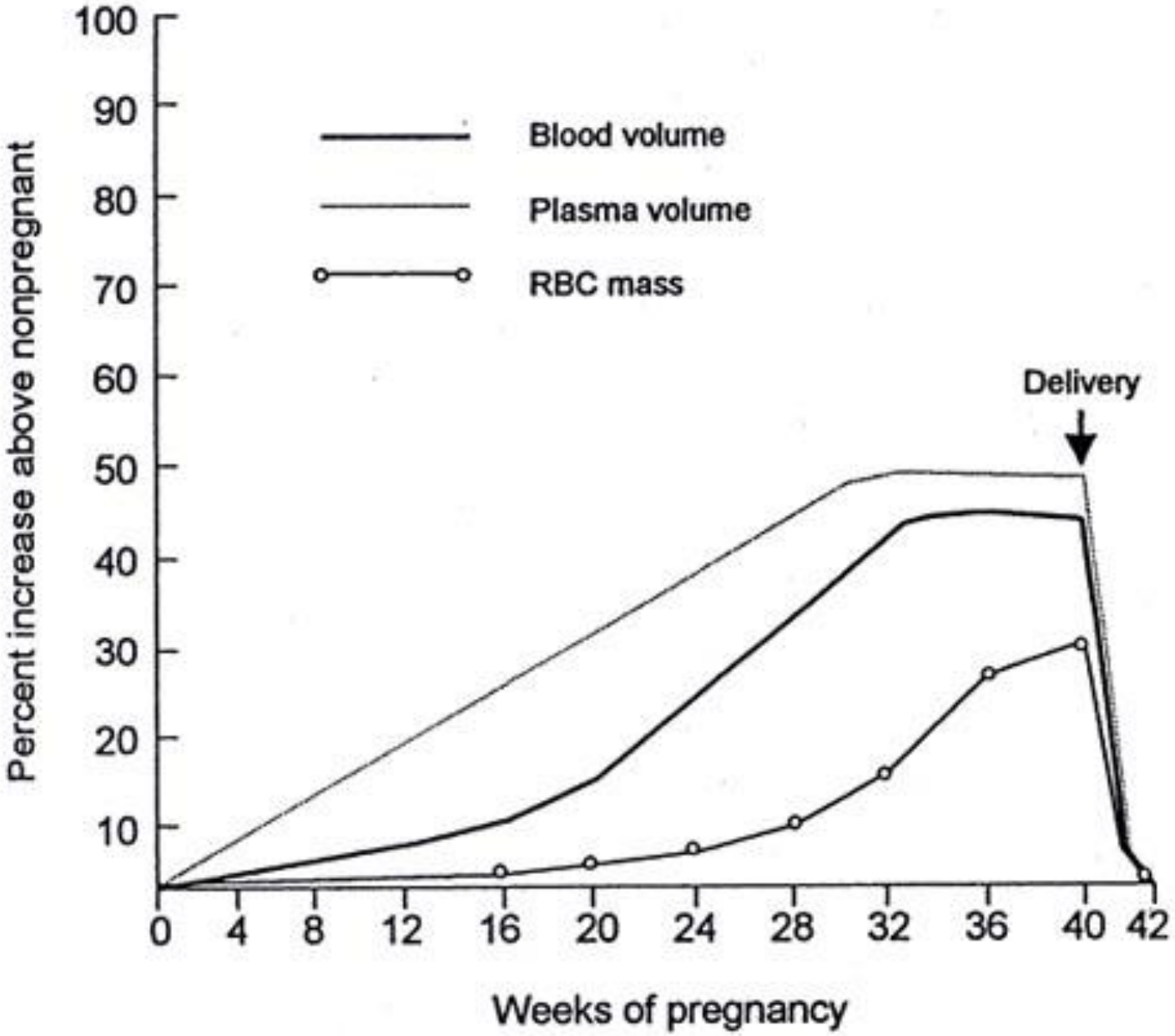

Figure 3–11. Blood volume changes during pregnancy. (From Scott D: Anemia during pregnancy. Obstet Gynecol Ann 1:219, 1972.)

- ***Haematological Changes***
- **Decreases in:**
  - **Haemoglobin concentration**
  - **Haematocrit**
  - **Plasma folate concentration**
- **Increases in:**
  - **White cell count**
  - **Erythrocyte sedimentation rate**
  - **Fibrinogen**

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CARDIOVASCULAR SYSTEM

- **Normal changes in heart sounds during pregnancy:**
- Increased loudness of both s1 and s2
- Increased splitting of mitral and tricuspid components of s1
- No constant changes in s2
- Loud s3 by 20 weeks' gestation
- <5% with s4
- >95% develop systolic murmur which disappears after delivery
- 20% have a transient diastolic murmur
- 10% develop continuous murmurs due to increased mammary blood flow

- **Cardiovascular Changes**
- Heart rate increases (10-20%)
- Stroke volume increases (10%)
- Cardiac output increases (30-50%)
- Mean arterial pressure decreases (10%)
- Peripheral resistance decreases (35%)

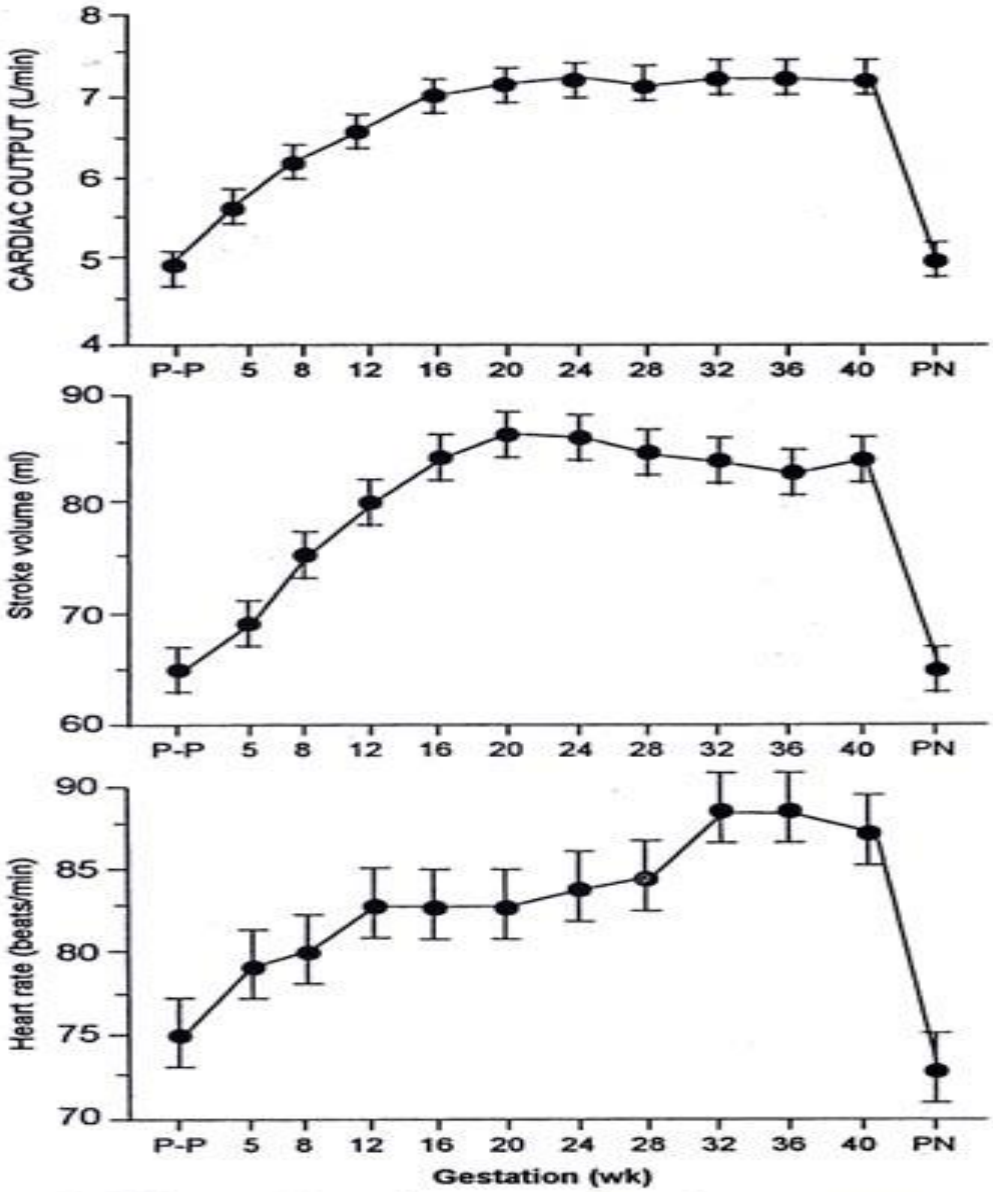
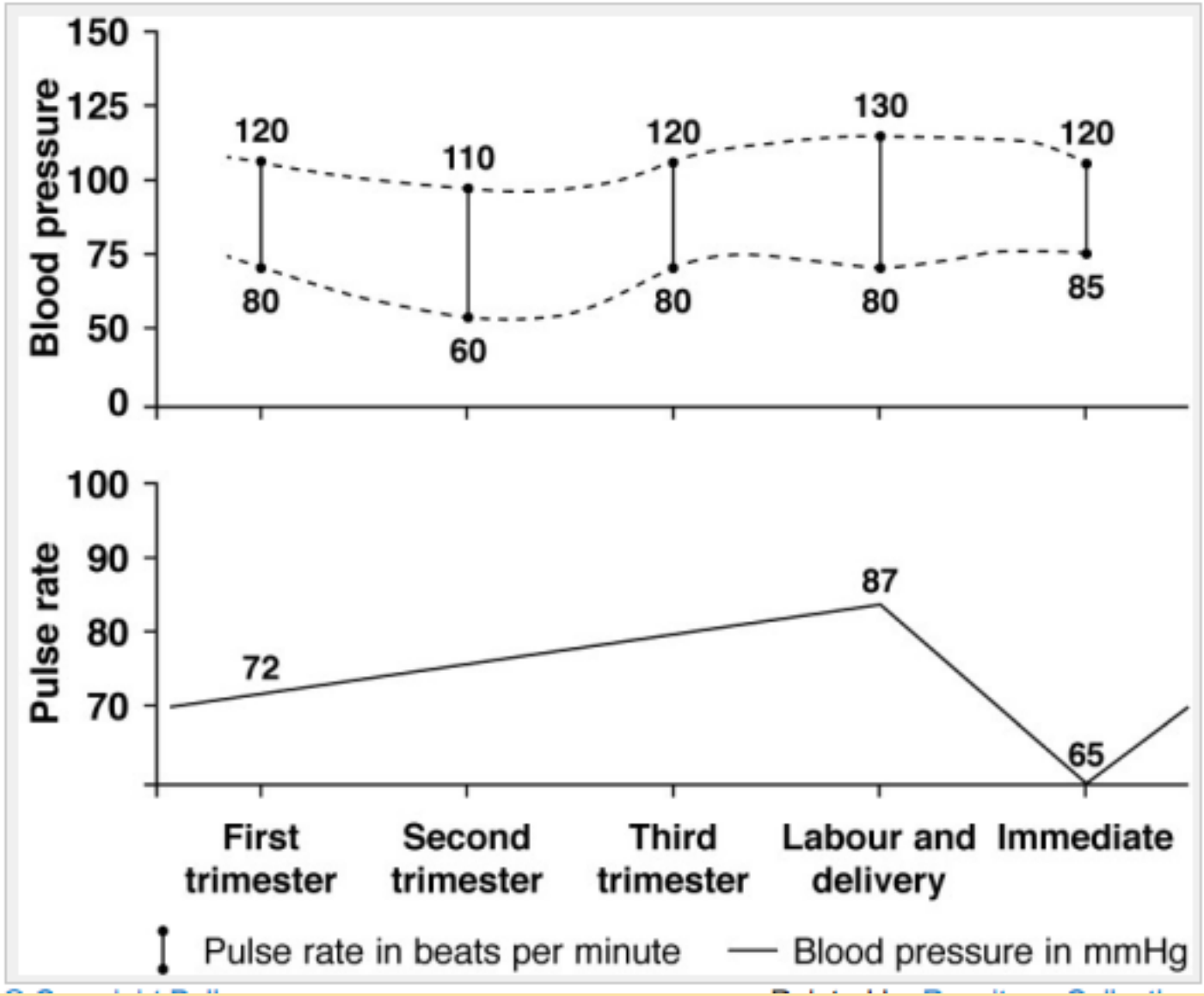


Figure 3–3. Increase in cardiac output from the nonpregnancy state throughout pregnancy. P-P, pre-pregnancy; PN, postnatal. (From Hunter S, Robson S: Adaptation of the maternal heart in pregnancy. Br Heart J 68:540, 1992, with permission.)


Blood pressure
150
125
100
75
50
0
120
110
120
130
120
80
60
80
80
85
Pulse rate
100
90
80
70
72
87
65
First trimester
Second trimester
Third trimester
Labour and delivery
Immediate
Pulse rate in beats per minute
Blood pressure in mmHg

SIGNS & SYMPTOMS OF NORMAL PREGNANCY THAT MAY MIMIC HEART DISEASE

- Signs
  - Peripheral edema
  - JVP
- Symptoms
  - Reduced exercise tolerance
  - Dyspnea

- Auscultation
  - S3 gallop
  - Systolic ejection murmur
- Chest x-ray
  - Change in heart position & size
  - Increased vascular markings
- EKG
  - Nonspecific ST-T wave changes
  - Axis deviation
  - LVH

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CHANGES IN THE FILTER

- Renin – stimulated by progesterone
  - Also made by placenta → Angiotensinogen → Angiotensin I → Angiotensin II → Aldosterone → Distal tubule
    - Net absorption of Na^+
    - Excretion of K^+
    - Water retention: **6-8 liters**
- Increased renal blood flow
  - 50-75% increase
  - GFR – 50% increase
  - Decreased Albumin = lower colloid oncotic pressure

OTHER URINARY TRACT CHANGES

- Ureteral dilation / hydroureter
  - Smooth muscle relaxation
  - Later exacerbation by uterine obstruction
  - Urinary stasis*
- Dilation of pelvis and calyces
- Increased kidney size

- ***THE URINARY TRACT AND RENAL FUNCTION***

- Renal changes
- Blood flow increases (60-75%)
- Glomerular filtration increases (50%)
- Clearance of most substances is enhanced
- Plasma creatinine, urea and urate are reduced
- Glycosuria is normal

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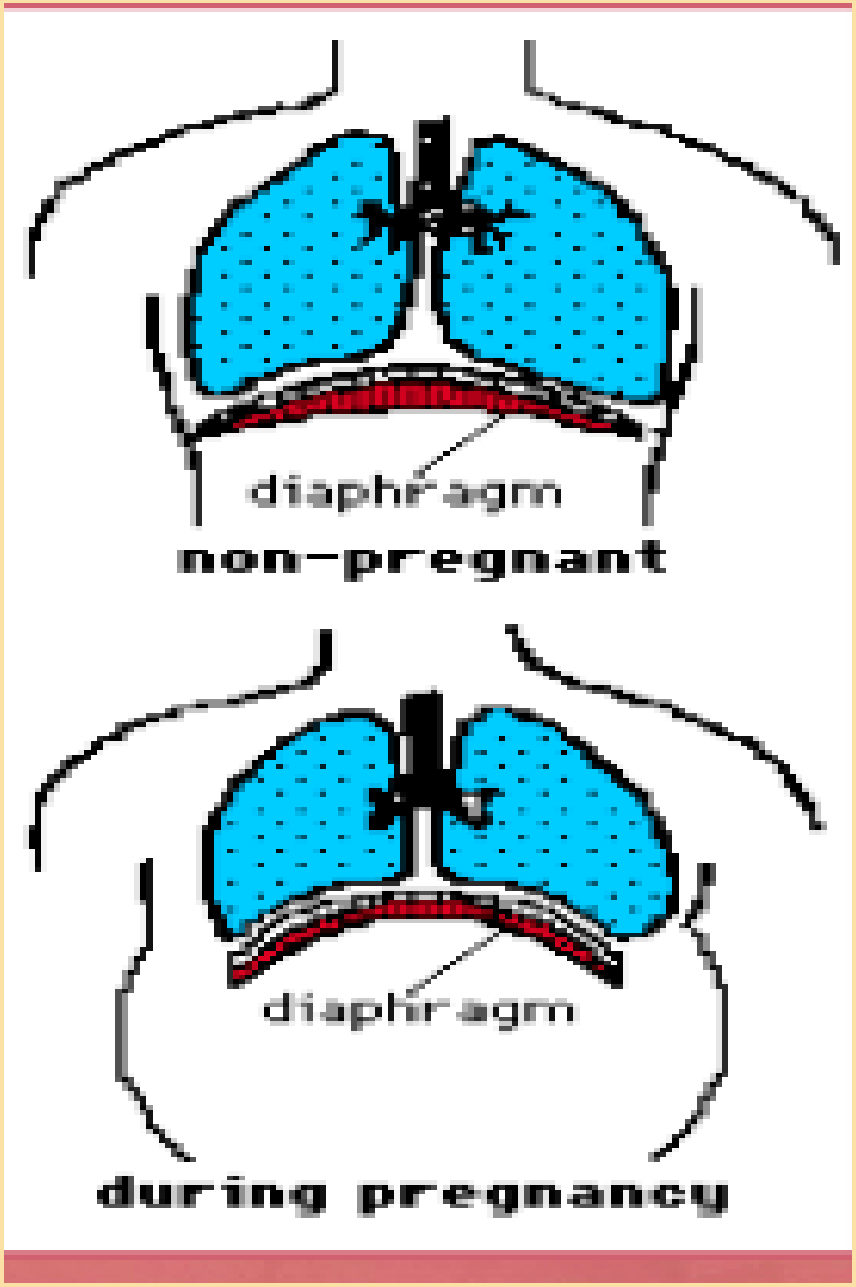
RESPIRATORY SYSTEM

- Mechanical
  - diaphragm
- Consumption
  - Increase in needed oxygen
- Stimulation
  - Progesterone stimulation

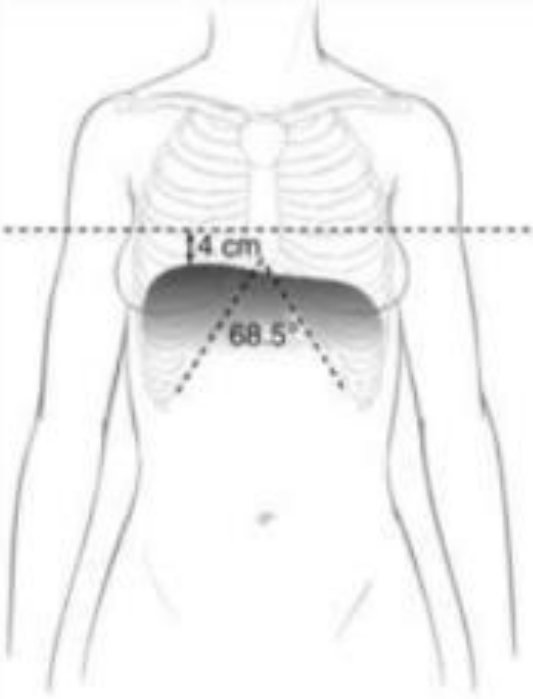

diaphragm
non-pregnant
diaphragm
during pregnancy

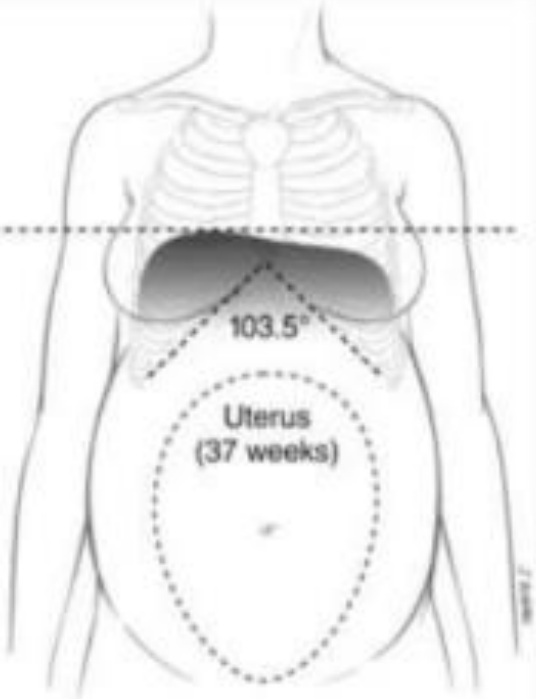
RESPIRATORY

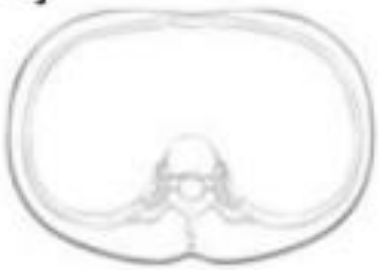
- Consumption
  - O2 consumption Increases 15-20 %
  - 50 % of this increase is required by the uterus
  - Despite increase in oxygen requirements, with the increase in Cardiac Output and increase in alveolar ventilation oxygen consumption exceeds the requirements.
  - Therefore, arteriovenous oxygen difference falls and arterial PCO2 falls.

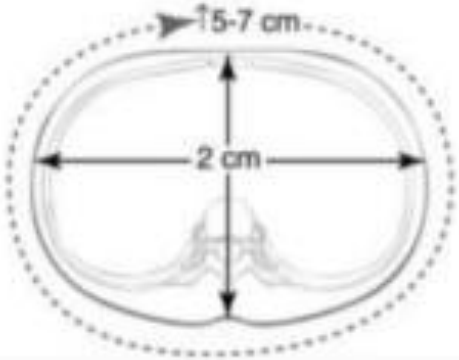
Pulmonary changes

- 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 by 15%
- Minute ventilation +30-40%
- Mild respiratory alkalosis









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ENDOCRINE GLANDS

1. **Pituitary gland**
   - FSH and LH ↓
   - ACTH, Thyrotrophin, melanocyte hormone and prolactin ↑
   - Prolactin level ↑ until the 30th week of pregnancy then more slowly to term.
2. **Adrenal gland**

   Total corticosteroids ↑ progressively to term. This will ↑ the tendency of pregnant women to develop abdominal strine, glycosuria and hypertension

3. Thyroid gland

- 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.
- Oestrogen stimulates or increased secretion of thyroxin in binding globulin.
- Both T3 and T4 levels rise. This rise will not indicate hyperthyroidism

OTHER ENDOCRINE

- Pancreas
  - Carbohydrate metabolism -Insulin resistance
    - Human placental lactogen, cortisol
- Thyroid Function
  - Increased TIBG (via liver)
  - Increased total T_4 and T_3
    - free levels unchanged
    - HCG suppresses TSH
- Adrenal function
  - Free plasma cortisol is elevated
    - CRH from placenta stimulates ACTH

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GASTROINTESTINAL

- Slowed GI motility
  - Constipation, early satiety
- Relaxation of LES
  - GERD
- Nausea / vomiting
  - Often proportional to HCG level
- Liver / gallbladder
  - Biliary stasis, cholesterol saturation
    - More stones
  - Coagulation factors
  - Increased binding proteins (thyroid, steroid, vitamin D)

Physiologic changes -

- **GASTROINTESTINAL**

- **Digestive system slow due to progesterone**
- Nausea and vomiting
- Ptyalism: increase salivation
- Heartburn
- Hemorrhoids
- **Prolonged gallbladder emptying time may lead to gall stones**
- **Bile salt buildup may lead to itching.**

GASTROINTESTINAL TRACT

- Displacement of the stomach and intestines
- Appendix can be displaced to reach the right flank
- Gastric emptying and intestinal transit times are delayed secondary to hormonal and mechanical factors
- Pyrosis is common due to the reflux of secretions
- Vascular swelling of the gums
- Hemorrhoids due to elevated pressure in veins

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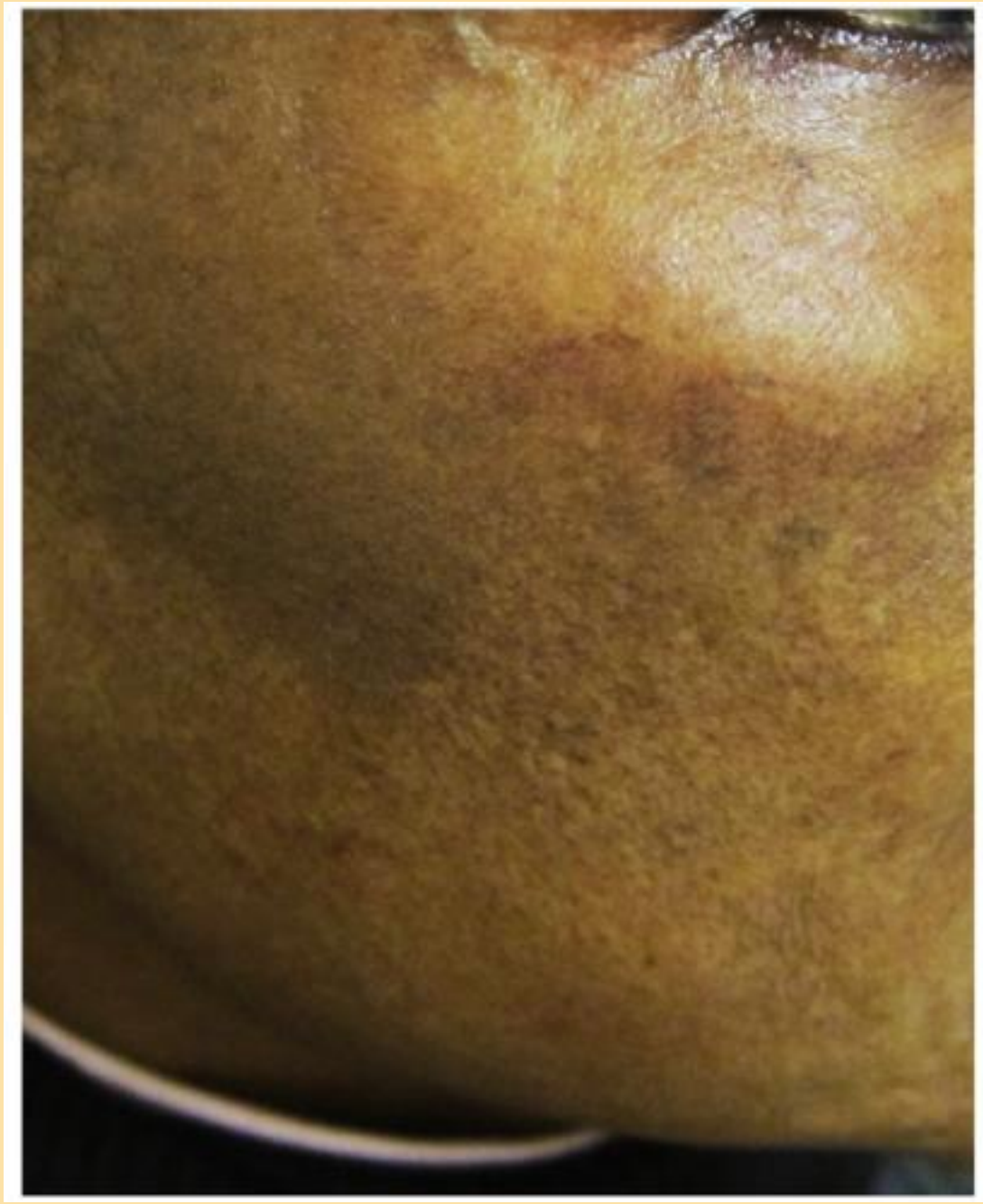
- Chloasma or melasma gravidarum
- Striae
- Linea nigra



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MSK CHANGES

- Musculoskeletalconsequencesthatensueasa result of hormonal changes and weight gain (28lbs ave) include:
- – Force across a joint is increased up to two-fold
- – Joint laxity (Relaxin) in the anterior and posterior longitudinal ligaments of the lumbar spine put strain on the lumbar spine.
- – There is widening and increased mobility of the sacroiliac joints and pubic symphysis to facilitate the baby's passage through the birth canal.
- – A significant increase in the anterior tilt of the pelvis occurs, with increased use of hip extensor, abductor, and ankle plantar flexor muscles

WEIGHT CHANGES

Weight.. Where do the pregnancy Kilos go?

Where do the pregnancy Kilos go?	
Maternal stores of nutrients and muscle development	3 Kg
Increased body fluid	2 Kg
Increased blood	1.5 - 2 Kg
Breast growth	600g
Enlarged uterus	1 Kg
Amniotic fluid	1 Kg
Placenta	600g
Baby	3.4 - 4 Kg
Total	**11 - 16 Kg**

Weight increase

1st Trimester	2nd Trimester	3rd Trimester
1 kg	5 kg	5 kg

- There is an increase weight of approximately 12.5 Kg at term.

- The main increase occurs in the 2nd half of the pregnancy, 0.5 Kg/week

Healthy weight gain during pregnancy

Pre-pregnancy BMI	Weight gain in kilograms	Weight gain in pounds
Underweight (under 18.5 BMI)	12.5-18	28-40
Normal weight (18.5-25 BMI)	11.5-16	25-35
Overweight (25-30 BMI)	7-11.5	15-25
Obese	5-9	11-20

TRISH McALASTER / THE GLOBE AND MAIL
SOURCE: U.S. INSTITUTE OF MEDICINE

ANATOMICAL CHANGES

- ***REPRODUCTIVE ORGANS***
- **The Uterus**
- **The Cervix**
- ***BREASTS AND LACTATION***

GENITAL TRACT CHANGES

1. UTERUS

A. Uterine muscles grow to 15 times than pre-pregnancy length.

- Uterine weight increases from 50 g before pregnancy to 950 g at term.

- In the early weeks of pregnancy the growth is by hyperplasia and more partially by hypertrophy of the muscle fibers.

GENiTAL TRACT CHANGES (CON' T.)

- **By 20 weeks growth ceases and the uterus expands by distension.**
- **The uterine blood vessels also undergo hypertrophy and become increasingly coiled in the first half of pregnancy but no further growth after that.**
- **The lower uterine segment is that part of the lower uterus and upper cervix lying between the line of attachment of the pertoneum of the utero vesical pouch superiorly and the histological internal os interiorly.**

B. THE CERVIX

Becomes softer and swollen in pregnancy, with the result that columnar epithelium lining the cervical canal becomes exposed to the vaginal secretions.

Prostaglandins act on the collagen fibres, especially in the last week of pregnancy. At the some time collagenae 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.

C. VAGINA

The vaginal mucosa becomes thicker, the vaginal muscle hypertrophies.

There is alteration in the composition of the connective tissue, with the result that the vagina dilates more easily to accommodate the fetus during delivery.

Oestrogen $\rightarrow$ desquamanation of the superficial vaginal mucosal cells with $\uparrow$ in vaginal discharge when pathogenesis entre the vagina (candida, trichomas) they will flourish rapidly.