Physiological changes during pregnancy

Cardiovascular system

1. Blood
   a. Volume
      i. 45-50% increase in blood volume, variation depends on:
         1. size of woman
         2. number of previous pregnancies
         3. number of deliveries
         4. number of fetuses
      ii. Increased requirements due to:
          1. extra blood flow to uterus
          2. metabolic needs of fetus
          3. increased perfusion to other organs during pregnancy
      iii. Blood loss in delivery
           1. Loss of 500-600ml for vaginal delivery
           2. Loss 1000 ml for C-section
   b. Content
      i. Cells
         1. Red blood cells
            a. Approx 33% increase in red blood cell mass
            b. Decrease in hematocrit in second trimester as plasma volume expands at a rate exceeding red blood cell production
            c. Hematocrit increases or stabilizes near birth
         2. White blood cells
            a. Leukocytes increase from 4300-4500/mL to 5000-12000/mL in last trimester on average
            b. Can rise as high as 30,000/mL in abnormal deliveries
            c. PMN’s increase while other leukocytes maintain prepregnancy values
      ii. Fe and clotting factors
         1. Fe
            a. Fe needs increase with increased RBC production and increase in hemoglobin
            b. Babies needs supersede Mom’s and baby can have normal hgb even if Mom is anemic
            c. Mother needs up to 5-6mg/d of Fe in last trimester to maintain adequate hgb levels
         2. Clotting factors
            a. Increases in fibrinogen and factor VIII
            b. Smaller increases in Factors VII, IX, X, and XII
            c. Fibrinolytic activities are suppressed by unknown mechanism
            d. Plasminogen levels increase in proportion to fibrinogen
               i. Clotting and lysing activities are balanced
   2. Position and size of the heart
      a. Increasing size of uterus displaces heart upward, slightly to left, with a rotation moving apex laterally
      b. Approx 12% increase in size of heart
      c. Increased capacity of heart by 70-80mL
3. Heart physiology
   a. Blood pressure
      i. Slight decline in systemic blood pressure
         1. systolic pressure unchanged
         2. decrease in diastolic pressure by 5-10mmHg weeks 12-26
         3. returns to prepregnancy values by week 36
      ii. Decreases in venous return
          1. Obstruction of IVC by uterus
          2. Presenting portion of fetus depresses common iliac vein
          3. Result: decr CO, edema of lower extremities, decr bp
   b. Cardiac Output
      i. 40% increase
      ii. Can increase as much as 1.5 L/min over prepregnancy values
      iii. CO sensitive to changes in body position as pregnancy progresses
   c. Peripheral resistance
      i. Peripheral resistance =bp/CO
      ii. Incr in CO with little change in bp = decr in peripheral resistance

Respiratory system
1. anatomical changes
   a. capillary dilations in respiratory tract
      i. engorgement of nasophrynx, larynx, trachei, bronchi
      ii. changes in voice
      iii. difficulty breathing through nose (decreased lumen size)
   b. increased vascularization of lungs
   c. elevation of diaphragm with enlarging uterus (moves up to 4cm)
   d. increase in thoracic diameter by 2cm at the bottom and by 6 cm in circumference
   e. less muscle tone in the abdominal muscle
2. Lung volumes and capacities
   a. Lung volumes
      i. Dead volume increases due to relaxation of muscles in conducting passageways
      ii. Tidal volumes increase up to 50% as pregnancy progresses
      iii. Total capacity decreases by 5% due to encroachment by diaphragm
      iv. 20% decrease in functional residual capacity, residual volume, and respiratory reserve volume
      v. Increased alveolar ventilation (65%)
      vi. Increase inspiratory capacity (up to 10)
   b. Functional changes
      i. Slight increase in respiratory rate
      ii. 50% increase in minute ventilation
      iii. 40% increase in tidal volume
      iv. 15-20% increase in oxygen consumption
      v. Hyperventilation of pregnancy = decrease in CO2
         1. protects fetus from exposure to elevated CO2

Urinary system
1. kidney
a. increases 1-1.5cm
b. renal pelvis is dilated
c. ureters are dilated above boney pelvis
d. elongation of ureters, widening leads to increase in urinary stasis and incr chance of infection
e. GFR increased by 50% during pregnancy
f. 50% increase in renal plasma volume
g. No increase in volume of urine = requires increase efficiency n the urinary system
h. Glucosuria is not abnormal due to increased GFR with no increase in capacity to reabsorb sugar
i. Increased rennin production > angiotensinogen when active has vasoconstrictor properties

2. bladder
   a. flattened and moved forward as uterus enlarges
   b. increased urinary frequency due to pressure
   c. decrease in muscle tone
d. increase in bladder vascularity
e. increased bladder capacity to 1500ml

Gastrointestinal system
1. General
   a. Increased nutritional requirements
   b. Increased maternal appetite
c. Morning sickness = due to increased levels of HCG (not experienced by all)

2. Changes in oral cavity
   a. Increased salivation
   b. Decr in pH = can result in dental carries
   c. Gums = hypertrophy, hyperemic, friable (due to increased estrogen)
d. Bleeding and tender gums due to vitamin C deficiency

3. changes in motility
   a. sometimes reduced under influence of increased progesterone > decr motilin = stimulates smooth muscle in gut
   b. slower transit time, more water reabsorption = constipation

4. Esophagus and stomach
   a. Variable HCl production, usually reduced
   b. Increased gastrin production = incr stomach volume = decr stomach pH
c. Increased mucus
d. Decreased esophageal peristalis
   e. Gastric reflux increases with increased pregnancy (heartburn)

5. Intestines
   a. Displaced in abdominal cavity
   b. Decreased motility

6. Gallbladder
   a. Hypotonia = slowed or incomplete emptying
   b. Bile thickens = increased formation of gallstones

7. Liver
   a. No morphologic changes
   b. Double in serum alkaline phosphatase activity

Metabolic changes
1. Weight gain due to:
   a. uterus and contents
   b. increased breast tissue
   c. blood and water volume increases
   d. Average weight gain = 12.5 kg (how many pounds is this?)
2. Protein
   a. accounts for 1000g of weight gain
   b. fetus, placenta, uterine contractile proteins, breast glandular tissue,
      plasma protein, hgb
3. Total body fat
   a. plasma lipids increase during second trimester
   b. triglycerides, cholesterol, lipoproteins decrease after delivery