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**1. Elucidate the physiological adaptations of the female to pregnancy.**

Adaptations to pregnancy refers to the changes in gait, postural parameters, as well as sensory feedback, due to the numerous anatomical, physiological and hormonal changes women experience during pregnancy .

 In order to meet with the demands of pregnancy, physiological adaptations allow her to support and protect the foetus.

The pregnant woman's body goes through some profound anatomical, physiologic, and biochemical changes to adapt to and support the entire pregnancy, which ultimately support the growing fetus. Although these physiologic changes are normal, often they can be misinterpreted as disease. These changes may also unmask or worsen a preexisting condition or disease, ultimately because the pregnant woman's body cannot adequately adapt to the changes of pregnancy.

This includes the basic adaptations related to pregnancy, placental physiology and action, uterine activity physiology, and fetal heart rate regulation etc.

Adaptation is defined as a change or adjustment to improve something, or to make it suitable to a different situation.

 various adaptations include:

**1. Hormonal**

Pregnant women experience numerous adjustments in their [endocrine system](file:///C%3A%5Cwiki%5CEndocrine_system) that help support the developing fetus. The fetal-placental unit secretes steroid hormones and proteins that alter the function of various maternal [endocrine glands](file:///C%3A%5Cwiki%5CEndocrine_gland). Sometimes, the changes in certain hormone levels and their effects on their target organs can lead to [gestational diabetes](file:///C%3A%5Cwiki%5CGestational_diabetes) and [gestational hypertension](file:///C%3A%5Cwiki%5CGestational_hypertension).

**Fetal-placental unit**

Levels of progesterone and estrogen rise continually throughout pregnancy, suppressing the hypothalamic axis and subsequently the menstrual cycle. The progesterone is first produced by the [corpus luteum](file:///C%3A%5Cwiki%5CCorpus_luteum) and then by the placenta in the second trimester. Women also experience increased [human chorionic gonadotropin](file:///C%3A%5Cwiki%5CHuman_chorionic_gonadotropin) (β-hCG), which is produced by the placenta.

### Pancreatic Insulin

The placenta also produces [human placental lactogen](file:///C%3A%5Cwiki%5CHuman_placental_lactogen) (hPL), which stimulates maternal lipolysis and fatty acid metabolism. As a result, this conserves blood glucose for use by the fetus. It can also decrease maternal tissue sensitivity to insulin, resulting in [gestational diabetes](file:///C%3A%5Cwiki%5CGestational_diabetes).

### Pituitary gland

The [pituitary gland](file:///C%3A%5Cwiki%5CPituitary_gland) grows by about one-third as a result of hyperplasia of the lactotrophs in response to the high plasma estrogen. [Prolactin](file:///C%3A%5Cwiki%5CProlactin), which is produced by the lactotrophs increases progressively throughout pregnancy. Prolactin mediates a change in the structure of the breast [mammary glands](file:///C%3A%5Cwiki%5CMammary_gland) from ductal to lobular-alveolar and stimulates milk production.

### Parathyroid

Fetal skeletal formation and then later lactation challenges the maternal body to maintain their calcium levels. The fetal skeleton requires approximately 30 grams of calcium by the end of pregnancy. The mother's body adapts by increasing [parathyroid hormone](file:///C%3A%5Cwiki%5CParathyroid_hormone), leading to an increase in calcium uptake within the gut as well as increased calcium reabsorption by the kidneys. Maternal total serum calcium decreases due to maternal [hypoalbuminemia](file:///C%3A%5Cwiki%5CHypoalbuminemia), but the ionized calcium levels are maintained.

### Adrenal glands

Total [cortisol](file:///C%3A%5Cwiki%5CCortisol) increases to three times of non-pregnant levels by the third trimester. The increased estrogen in pregnancy leads to increase corticosteroid-binding globulin production and in response the [adrenal gland](file:///C%3A%5Cwiki%5CAdrenal_gland) produces more cortisol. The net effect is an increase of free cortisol. This contributes to insulin resistance of pregnancy and possibly striae. Despite the increase in cortisol, the pregnant mom does not exhibit [Cushing syndrome](file:///C%3A%5Cwiki%5CCushing_syndrome) or symptoms of high cortisol.

The adrenal gland also produces more [aldosterone](file:///C%3A%5Cwiki%5CAldosterone), leading to an eight-fold increase in aldosterone. Women do not show signs of hyperaldosterone, such as hypokalemia, hypernatremia, or high blood pressure.

The adrenal gland also produces more [androgens](file:///C%3A%5Cwiki%5CAndrogens), such as testosterone, but this is buffered by estrogen's increase in sex-hormone binding globulin (SHBG). SHBG binds avidly to testosterone and to a lesser degree DHEA.

### Thyroid

The [thyroid](file:///C%3A%5Cwiki%5CThyroid) enlarges and may be more easily felt during the first trimester. The increase in kidney clearance during pregnancy causes more iodide to be excreted and causes relative iodine deficiency and as a result an increase in thyroid size. Estrogen-stimulated increase in thyroid-binding globulin (TBG) leads to an increase in total [thyroxine](file:///C%3A%5Cwiki%5CThyroxine) (T4), but free thyroxine (T4) and [triiodothyronine](file:///C%3A%5Cwiki%5CTriiodothyronine) (T3) remain normal.

**2. Breast size**

A woman's breasts grow during pregnancy, usually 1 to 2 cup sizes and potentially several cup sizes. A woman who wore a particular cup bra prior to her pregnancy may need to buy a larger bra while nursing. A woman's torso also grows and her bra band size may increase one or two sizes. An average of 80% of women wear the wrong bra size, and mothers who are preparing to nurse can benefit from a professional bra fitting from a lactation consultant. Once the baby is born up to about 50–73 hours after birth, the mother will experience her breasts filling with milk . Once [lactation](file:///C%3A%5Cwiki%5CLactation) begins, the woman's breasts swell significantly and can feel achy, lumpy and heavy which is referred to as engorgement. Her breasts may increase in size again by an additional 1 or 2 cup sizes, but individual breast size may vary depending on how much the infant nurses from each breast. A regular pattern of nursing is generally established after 8–12 weeks, and a woman's breasts will usually reduce in size, but may remain about 1 cup size larger than prior to her pregnancy. Changes in breast size during pregnancy may be related to the sex of the infant, as mothers of female infants have greater changes in breast size than mothers of male infants.

 In actuality, breastfeeding is not considered to be a major contributor to ptosis of the breasts. In fact, the biggest factors affecting ptosis are cigarette smoking, a woman's [body mass index](file:///C%3A%5Cwiki%5CBody_mass_index) (BMI), her [number of pregnancies](file:///C%3A%5Cwiki%5CGravidity), her [breast cup size](file:///C%3A%5Cwiki%5CCleavage_%28breasts%29) before pregnancy, and age.

**3. Cardiovascular**

The heart adapts to the increased cardiac demand that occurs during pregnancy in many ways.

* Cardiac output (Lit./Min.): 6.26
* Stoke Volume (Ml.): 75
* Heart Rate (Per min.): 85
* Blood Pressure: Unaffected

Cardiac output increases throughout early pregnancy, and peaks in the third trimester, usually to 30-50% above baseline. Estrogen mediates this rise in cardiac output by increasing the pre-load and stroke volume, mainly via a higher overall blood volume (which increases by 40–50%). The heart rate increases, but generally not above 100 beats/ minute. Total systematic vascular resistance decreases by 20% secondary to the vasodilatory effect of progesterone. Overall, the systolic and diastolic blood pressure drops 10–15 mm Hg in the first trimester and then returns to baseline in the second half of pregnancy. All of these cardiovascular adaptations can lead to common complaints, such as palpitations, decreased exercise tolerance, and dizziness.

Uterine enlargement beyond 20 weeks' size can compress the inferior vena cava, which can markedly decrease the return of blood into the heart or preload. As a result, healthy pregnancy patients in a supine position or prolonged standing can experience symptoms of hypotension.

**4. Metabolic**

During pregnancy, both [protein metabolism](file:///C%3A%5Cwiki%5CProtein_metabolism)and [carbohydrate metabolism](file:///C%3A%5Cwiki%5CCarbohydrate_metabolism) are affected. One [kilogram](file:///C%3A%5Cwiki%5CKilogram) of extra [protein](file:///C%3A%5Cwiki%5CProtein) is deposited, with half going to the [fetus](file:///C%3A%5Cwiki%5CFetus) and [placenta](file:///C%3A%5Cwiki%5CPlacenta), and another half going to [uterine](file:///C%3A%5Cwiki%5CUterus) contractile proteins, [breast glandular](file:///C%3A%5Cwiki%5CBreast_gland) tissue, plasma protein, and [haemoglobin](file:///C%3A%5Cwiki%5CHaemoglobin).

An increased requirement for nutrients is given by fetal growth and fat deposition. Changes are caused by steroid hormones, lactogen, and cortisol.

Maternal insulin resistance can lead to [gestational diabetes](file:///C%3A%5Cwiki%5CGestational_diabetes). Increased liver metabolism is also seen, with increased gluconeogenesis to increase maternal glucose levels.

**Body weight**

Some degree of weight gain is expected during pregnancy. The enlarging uterus, growing fetus, [placenta](file:///C%3A%5Cwiki%5CPlacenta), [amniotic fluid](file:///C%3A%5Cwiki%5CLiquor_amnii), normal increase in body fat, and increase in water retention all contribute weight gain during pregnancy. The amount of weight gain can vary from 5 pounds (2.3 kg) to over 100 pounds (45 kg). In the United States, the range of weight gain that doctors generally recommend is 25 pounds (11 kg) to 35 pounds (16 kg), less if the woman is overweight, more (up to 40 pounds (18 kg)) if the woman is underweight.

**Nutrition**

Nutritionally, pregnant women require a caloric increase of 350 kcal/day and an increase in protein to 70 or 75 g/day. There is also an increased [folate](file:///C%3A%5Cwiki%5CFolate) requirement from 0.4 to 0.8 mg/day . On average, a weight gain of 20 to 30 lb (9.1 to 13.6 kg) is experienced.

All patients are advised to take [prenatal vitamins](file:///C%3A%5Cwiki%5CPrenatal_vitamins) to compensate for the increased nutritional requirements. The use of Omega 3 fatty acids supports mental and visual development of infants. Choline supplementation of research mammals supports mental development that lasts throughout life.

**5. Respiration**

There are many physiologic changes that occur during pregnancy that influence respiratory status and function. Progesterone has noticeable effects on respiratory physiology, increasing [minute volume](file:///C%3A%5Cwiki%5CMinute_ventilation) by 40% in the first trimester via an increase in [tidal volume](file:///C%3A%5Cwiki%5CTidal_volume) alone, as the respiratory rate does not change during pregnancy. As a result, [carbon dioxide](file:///C%3A%5Cwiki%5CCarbon_dioxide)levels in the blood decrease and the [pH](file:///C%3A%5Cwiki%5CPH) of the blood becomes more alkaline. This causes the maternal kidneys to excrete [bicarbonate](file:///C%3A%5Cwiki%5CBicarbonate) to compensate for this change in pH. The combined effect of the decreased serum concentrations of both carbon dioxide and bicarbonate leads to a slight overall increase in blood pH (to 7.44 compared to 7.40 in the non-pregnant state) . If an [arterial blood gas](file:///C%3A%5Cwiki%5CArterial_blood_gas_test) (ABG) specimen is drawn on a pregnant person, it would therefore reveal [respiratory alkalosis](file:///C%3A%5Cwiki%5CRespiratory_alkalosis) with a compensatory [metabolic acidosis](file:///C%3A%5Cwiki%5CMetabolic_acidosis).

As the uterus and fetus continue to enlarge over time, the diaphragm progressively becomes more upwardly displaced. This causes less space to be available for lung expansion in the chest cavity, and leads to a decrease in [expiratory reserve volume](file:///C%3A%5Cwiki%5CLung_volumes) and [residual volume](file:///C%3A%5Cwiki%5CLung_volumes). This culminates in a 20% decrease in [functional residual capacity](file:///C%3A%5Cwiki%5CFunctional_residual_capacity) (FRC) during the course of the pregnancy.

Oxygen consumption increases by 20% to 40% during pregnancy, as the oxygen demand of the growing fetus, placenta, and increased metabolic activity of the maternal organs all increase the pregnant person's overall oxygen requirements. This increase in oxygen consumption paired with the decrease in FRC can potentially mean that pregnant people with pre-existing or [comorbid](file:///C%3A%5Cwiki%5CComorbidity) asthma, pneumonia, or other respiratory issues may be more prone to disease exacerbation and respiratory decompensation during pregnancy.

**6. Immune tolerance**

The [fetus](file:///C%3A%5Cwiki%5CFetus) inside a pregnant woman may be viewed as an unusually successful [allograft](file:///C%3A%5Cwiki%5CAllograft), since it genetically differs from the woman. In the same way, many cases of [spontaneous abortion](file:///C%3A%5Cwiki%5CSpontaneous_abortion) may be described in the same way as maternal [transplant rejection](file:///C%3A%5Cwiki%5CTransplant_rejection).

**7. Rental and lower reproductive tract**

Progesterone causes many changes to the genitourinary system. A pregnant woman may experience an increase in the size of the kidneys and ureter due to the increase blood volume and vasculature. Later in pregnancy, the woman might develop physiological hydronephrosis and hydroureter, which are normal. Progesterone causes vasodilatation and increased blood flow to the kidneys, and as a result [glomerular filtration rate](file:///C%3A%5Cwiki%5CGlomerular_filtration_rate) (GFR) commonly increases by 50%, returning to normal around 20 weeks [postpartum](file:///C%3A%5Cwiki%5CPostpartum). The increased GFR increases the excretion of protein, albumin, and glucose. The increased GFR leads to increased urinary output, which the woman may experience as increased urinary frequency. Progesterone also causes decreased motility of the ureters, which can lead to stasis of the urine and hence an increased risk of urinary tract infection.

Pregnancy alters the [vaginal microbiota](file:///C%3A%5Cwiki%5CList_of_microbiota_species_of_the_lower_reproductive_tract_of_women) with a reduction in species or genus diversity. Physiological hydronephrosis may appear from six weeks.

**8. Gastrointestinal:**

Changes in the gastrointestinal (GI) system during pregnancy are caused by the enlarging uterus and hormonal changes of pregnancy. Anatomically, the intestine and stomach are pushed up from their original positions by the enlarging uterus. While there aren't any intrinsic changes in the sizes of the GI organs, the portal vein increases in size due to the hyper dynamic state of pregnancy. Elevated levels of [progesterone](file:///C%3A%5Cwiki%5CProgesterone) and [estrogen](file:///C%3A%5Cwiki%5CEstrogen) mediate most of the functional changes of the GI system during pregnancy. Progesterone causes smooth muscle relaxation which slows down GI motility and decreases [lower esophageal sphincter](file:///C%3A%5Cwiki%5CLower_esophageal_sphincter) (LES) tone. The resulting increase in intragastric pressure combined with lower LES tone leads to the gastroesophageal reflux commonly experienced during pregnancy.

The increased occurrence of gallstones during pregnancy is due to inhibition of gallbladder contraction and reduced biliary transportation of bile which results in [cholestasis of pregnancy](file:///C%3A%5Cwiki%5CCholestasis_of_pregnancy).

Nausea and vomiting of pregnancy, commonly known as “[morning sickness](file:///C%3A%5Cwiki%5CMorning_sickness)”, is one of the most common GI symptoms of pregnancy. It begins between the 4 and 8 weeks of pregnancy and usually subsides by 14 to 16 weeks. The exact cause of nausea is not fully understood but it correlates with the rise in the levels of [human chorionic gonadotropin](file:///C%3A%5Cwiki%5CHuman_chorionic_gonadotropin), [progesterone](file:///C%3A%5Cwiki%5CProgesterone), and the resulting relaxation of smooth muscle of the stomach. [Hyperemesis gravidarum](file:///C%3A%5Cwiki%5CHyperemesis_gravidarum), which is a severe form of nausea and vomiting of pregnancy can lead to nutritional deficiencies, weight loss, electrolytes imbalance and is one of the leading causes of hospitalization in the first trimester of pregnancy.

[Constipation](file:///C%3A%5Cwiki%5CConstipation) is another GI symptom that is commonly encountered during pregnancy. It is associated with the narrowing of the colon as it gets pushed by the growing uterus found adjacent it leading to mechanical blockade. Reduced motility in the entire GI system as well as increased absorption of water during pregnancy are thought to be contributing factors.

Dietary cravings and dietary as well as olfactory avoidance of certain types of food are common in pregnancy. Although the exact mechanisms of these symptoms are not fully explained, it is thought that dietary cravings may arise from the thought that certain foods might help relieve nausea.  [Pica](file:///C%3A%5Cwiki%5CPica_%28disorder%29), which is the intense craving for unusual materials such as clay and ice has also been reported in pregnancy.

Hemorrhoids and gingival disease are two common pregnancy associated physical findings involving the gastrointestinal system. Hemorrhoids arise as a result of constipation and venous congestion that are common in pregnancy. Gingival disease is thought to be related to gum softening and edema that is mostly observed in pregnancy.

**9. Hematology**

During pregnancy the [plasma](file:///C%3A%5Cwiki%5CBlood_plasma) volume increases by 40-50% and the red blood cell volume increases only by 20–30%. These changes occur mostly in the second trimester and prior to 32 weeks gestation. Due to dilution, the net result is a decrease in [hematocrit](file:///C%3A%5Cwiki%5CHematocrit) or hemoglobin, which are measures of red blood cell concentration. [Erythropoietin](file:///C%3A%5Cwiki%5CErythropoietin), which stimulates red blood cell production, increases throughout pregnancy and reaches approximately 150 percent of their pregnancy levels at term. The slight drop in hematocrit or hemoglobin is most pronounced at the end of the second trimester and slowly improves when reaching term.