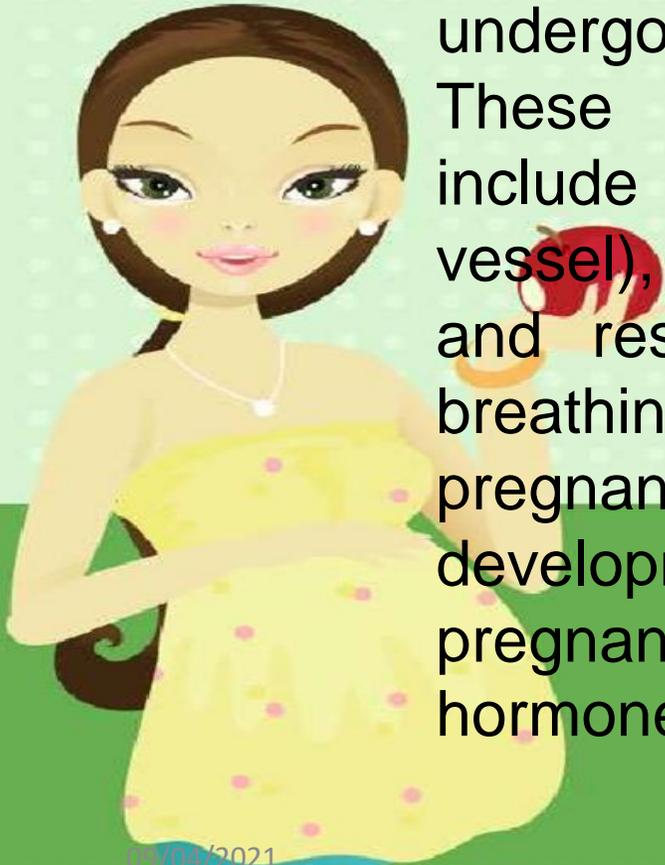


PHYSIOLOGICAL CHANGES DURING PREGNANCY



INTRODUCTION

physiological changes in pregnancy are the adaptations during pregnancy that the pregnant woman's body undergoes to accommodate the growing embryo or fetus. These physiologic changes are entirely normal, and include cardiovascular (heart and blood vessel), hematologic (blood), metabolic, renal (kidney), posture, and respiratory (breathing) changes. Increases in blood sugar, breathing, and cardiac output are all expected changes that allow a pregnant woman's body to facilitate the proper growth and development of the embryo or fetus during the pregnancy. The pregnant woman and the placenta also produce many other hormones that have a broad range of effects during the pregnancy.



CHANGES IN GENITAL ORGANS



- Vulva
- Vagina
- Uterus
- Isthmus
- Cervix
- Fallopian Tube
- Ovary

Vulva

- Oedematous
- More Vascular
- Superficial varicosities may appear specially in multiparae.
- Labia minora are pigmented and hypertrophied



Vagina



- Vaginal walls become hypertrophied, oedematous and more vascular.
- Increased blood supply of the venous plexus surrounding the walls
- The length of the anterior vaginal wall is increased.
- **Secretion** becomes copious, thin and curdy white
- **pH** becomes acidic (3.5-6)

Uterus

- Non-pregnant state weighs about 60gm, with a cavity of 5-10 ml and measures about 7.5 cm in length, at term, weighs 900-1000 gm and measures 35cm in length
- Changes occur in all the parts of uterus body, isthmus and cervix.
- Increase in growth and enlargement of the body of the uterus



Changes in the muscles

(1) Hypertrophy and hyperplasia-occur under the influence of the hormones-oestrogen and progesterone

(2) Stretching: The muscle fibres further elongate beyond 20 weeks due to distension by the growing foetus. The wall becomes thinner and at term, measures about 1.5cm or less.



Arrangement of the muscle fibres

1) Outer longitudinal – follows a hood like arrangement over the fundus; some fibres are continuous with the round ligaments

(2) Inner circular – It is scanty and have sphincter like arrangement around the tubal orifices and internal os

(3) Intermediate – It is the thickest and strongest layer arranged in criss-cross fashion through which the blood vessels run.

Apposition of two double curve muscle fibres give the figure of '8' form, it called as living ligature.



Vascular system



- Uterine artery diameter becomes double
- Blood flow increases by eight fold at 20 weeks of pregnancy.
- Vasodilatation is mainly due to estradiol and progesterone.
- Veins become dilated and are valveless.
- Numerous lymphatic channels open up.
- Vascular changes are most pronounced at the placental site

Weight

Weight is due to the increased growth of the uterine muscles, connective tissues and vascular channels



Shape

- Non pregnant pyriform shape is maintained in early months.
- Becomes globular at 12 weeks.
- As the uterus enlarge, the shape once more becomes pyriform or ovoid by 28 weeks
- Changes to spherical beyond 36th week



Position

- Normal anteverted positions exaggerated up to 8 weeks
- The enlarged uterus may lie on the bladder
- Afterwards, it becomes erect, the long axis of the uterus conforms more is a tendency of ante version
- Primigravidae with good tone of the abdominal muscles, it is held firmly against the maternal spine.



Contractions (Braxton-Hicks) : Irregular, infrequent, spasmodic and painless without any effect on dilatation of the cervix.

Endometrium : structural and secretory activity of the endometrium



Isthmus

- During the first trimester isthmus hypertrophies and elongates to about 3 times its original length
- Becomes softer



Cervix

- Hypertrophy and hyperplasia of the elastic and connective tissues
- Vascularity is increased
- Softening of the cervix (Goodell's sign)
- Squamous cells also become hyperactive
- Mucosal changes simulate basal cell hyperplasia or cervical intraepithelial neoplasia (CIN)
- Secretion is copious and tenacious – physiological leucorrhoea of pregnancy
- Becomes bulky



Fallopian Tube

- Total length is increased
- Tube becomes congested
- Muscles undergo hypertrophy



Ovary

- Growth and function of the corpus luteum reaches its maximum at 8th week
- Hormones-oestrogen and progesterone secreted by the corpus luteum maintain the environment for the growing ovum
- Control the formation and maintenance of decidua of pregnancy
- Inhibit ripening of the follicles



BREAST CHANGES

- Increased size of the breasts
- Marked hypertrophy and proliferation of the ducts (oestrogen and progesterone)
- Vascularity is increased
- The nipples become larger, erectile and deeply pigmented



- Sebaceous glands (5-15) become hypertrophied and are called **Montgomery's tubercles**
- Outer zone of less marked and irregular pigmented area appears in the second trimester and is called **secondary areola**
- Secretion (colostrum) can be squeezed out of the breast at about 12th week



CUTANEOUS CHANGES

Face (cholasma gravidarum or pregnancy mask)

an extreme form of pigmentation around the cheek, forehead and around the eyes



Abdomen

- **Linea nigra** : a brownish black pigmented area in the midline stretching from the xiphisternum to the symphysis pubis
- **Straie gravidarum** :slightly depressed linear marks with varying length and breadth found in pregnancy



Plasma Volume

- Starts to increase by 6 weeks
- Rate of increase almost parallels to that of blood volume
- Reached to the extent of 50%
- Total plasma volume increases to the extent of 1.25 liters



RBC And Haemoglobin

- The RBC mass is increased to the extent of 20-30%
- Increase demand of oxygen transport during pregnancy
- Disproportionate increase in plasma and RBC volume produces state of haemodilution (fall in haemocrit)
- Hb fall is about 2 gm.% from the non-pregnant value.



Leucocytes And Immune System

In the second and third trimester, the action of the polymorphoneuclear leukocytes may be depressed, perhaps accounting for the increased susceptibility of pregnant women to infection

Total plasma protein increases from the normal 180 gm. (non-pregnant) to 230 gm

Due to haemodilution (increase plasma volume), the plasma protein concentration falls from 7 gm.% to 6 gm.%

Blood Coagulation Factor Pregnancy is a **hypercoagulable state**. Plasma fibrinogen (factor 1) increases from the third month of pregnancy



METABOLIC CHANGES

General Metabolic Changes

- Total metabolism is increased due to the needs of the growing fetus and the uterus
- Basal metabolic rate is increased to the extent of 30% higher than that of the average for the non-pregnant women.

Protein Metabolism

- Positive nitrogenous balance throughout pregnancy
- At term, the fetus and the placenta contain about 500 gm. of protein and the maternal gain is also about 500 gm.



Carbohydrate Metabolism

- **Insulin secretion is increased** in response to glucose and amino acids.
- Hyperplasia and hypertrophy of beta cells of pancreas.
- Increased insulin level favours **lipogenesis** (fat storage). This mechanism ensures continuously supply of glucose to the fetus

Fat Metabolism

- An average of 3-4 kg of fat is stored during pregnancy mostly in the abdominal wall, breasts, hips and thighs



Iron Metabolism

- Iron is absorbed in ferrous form from duodenum and jejunum and is released into the circulation as transferrin
- 10 percent of ingested iron is absorbed
- Total iron requirement during pregnancy is estimated approximately 1000mg
- In the absence of iron supplementation, there is drop in haemoglobin, serum iron and serum ferritin concentration at term pregnancy



Weight Gain

- In early weeks, the patient may lose weight because of nausea and vomiting
- During subsequent months, the weight gain is progressive until the last one or two weeks, when the weight remains static
- **The total weight gain during the course of a singleton pregnancy for a healthy woman averages 11 kg**
- Distributed to 1 kg in first trimester and 5 kg each in second and third trimester



The total weight gain at term is distributed approximately as :



Reproductive weight gain : 6 kg	Net maternal weight gain : 6 kg
Fetus – 3.3 kg, placenta – 0.6 kg and liquor – 0.8 kg uterus – 0.9 kg and breast -0.4 kg, accumulation of the fat and protein – 3.5 kg	Increases in blood volume – 1.3 kg Increases in extracellular fluid – 1.2 kg

Calcium metabolism and locomotor system

- Relaxation of pelvic ligaments and muscles occurs because of the influence of estrogen and relaxin reaches maximum during last weeks of the pregnancy
- Increased lumbar lordosis during later months of the pregnancy due to enlarged uterus backache and waddling gait



SYSTEMIC CHANGES

Respiratory System

- Shape of the chest and the circumference increases in pregnancy by 6 cm
- Progressive increase in oxygen consumption, which is caused by the increased metabolic needs of the mother and fetus
- The mucosa of the nasopharynx becomes hyperaemic and oedematous
- **A state of hyperventilation occurs during pregnancy leading to increase tidal volume**
- The woman feels shortness of breath
- Pregnancy is a state of respiratory alkalosis



CARDIOVASCULAR CHANGES



The Heart :

- muscle, particularly the left ventricles, hypertrophies leading to enlargement of the heart
- The growing uterus pushes the heart upward and to the left
- During pregnancy the heart rate and stroke volume (the amount of the blood pumped by heart with each beat) increases due to the increase blood volume and oxygen requirement of the maternal tissues and growing fetus



Cardiac Output :



- increases markedly by the end of the first trimester.
- In the third trimester, a rise, fall or no change at all has been showed to occur, depending on individual variables.
- lowest in the sitting or supine position and highest in the right or left lateral or knee chest position.
- The capacity of veins and venules increases.
- Arterial walls relax and dilate due to the effect of progesterone. The increase production of vasodilator prostaglandin also contributes to this.

Blood Pressure



- During the mid-trimester, changes in blood pressure may occur causing fainting
- In later pregnancy, hypotension may occur in 10% of women in unsupported supine position. This termed as “**supine hypotensive syndrome**”
- The pressure of gravid uterus compresses the vena cava, reducing the venous return
- Cardiac output is reduced by 25-30 percent and the blood pressure may fall by 10-15 percent



Regional Distribution Of The Blood Flow

- **Uterine blood flow** is increased from 50 ml per minute in non-pregnant state about 750 ml near term
- **Pulmonary blood flow** (normal 6000ml/min) is increased by 2500 ml per minute
- **Renal blood flow** (normal 800 ml) increases by 400 ml per minute at 16th week remains at this level till term
- **Heat sensation, sweating or stuffy nose** complained by the pregnant women can be explained by the increased blood flow



Urinary System

- kidney

- Dilatation of the ureter, renal pelvis and calyces. The kidneys enlarge in length by 1 cm.
- **Renal plasma flow** is increased by 50-75%, maximum by the 16 weeks and is maintained until 34 weeks. Thereafter it falls by 25%.
- **Glomerular filtration rate (GFR)** is increased by 50% all throughout the pregnancy

- Ureter

- **ureters become atonic** due to high progesterone level.
- **Dilatation of the ureter** above the pelvic brim with stasis is marked on the right side specially in primigravidae.



- Bladder

- Increased frequency of micturition is noticed at 6-8 weeks of pregnancy which subside after 12 weeks and In late pregnancy, frequency of micturition once more reappears due to pressure on the bladder as the presenting part descends down the pelvis.
- **Stress incontinence** may observe in late pregnancy due to urethral sphincter weakness



Alimentary System

- Gums become congested and spongy and may bleed to touch
- Risk of peptic ulcer disease is reduced.
- Atonicity of the gut leads to constipation

Liver and gall bladder

- Liver functions are depressed
- High blood cholesterol level during pregnancy, favour stone formation



NERVOUS SYSTEM

- Temperamental changes are found during pregnancy and in the puerperium
- Nausea, vomiting, mental irritability and sleeplessness are probably due to some psychological background
- Postpartum blues, depression or psychosis may develop in a susceptible individual



CHANGES IN THE ENDOCRINE SYSTEM

Placental Hormones

- Placenta produces several hormones
- The high levels of estrogen and progesterone produced by the placenta are responsible for breast changes, skin pigmentations and uterine enlargement in the first trimester
- Chorionic gonadotrophin is the basis for the immunologic pregnancy tests
- Human placental lactogen stimulates the growth of the breasts



Pituitary Hormones

- The secretion of prolactin, adrenocorticotrophic hormone, thyrotrophic hormone and melanocyte-stimulating hormone increases
- Follicle stimulating hormone and luteinizing hormone secretion is greatly inhibited by placental progesterone and estrogen.
- The effects of prolactin secretion are suppressed during pregnancy
- Posterior pituitary gland releases oxytocin in low-frequency pulses throughout pregnancy. At term the frequency of pulses increases which stimulates uterine contractions



Thyroid Function

- Gland increases in size by about 13 percent due to hyperplasia of glandular tissue and increased vascularity
- Increased uptake of iodine during pregnancy
- Pregnancy can give the impression of hyperthyroidism, thyroid function is basically normal
- The basal metabolic rate is increased mainly because of increased oxygen consumption by the fetus and the work of the maternal heart and lungs



CONCLUSION

Pregnancy and its changes is a normal physiological process that happens in all mammalian in response to the development of the fetus. These changes happen in response to many factors; hormonal changes, increase in the total blood volume, weight gain, and increase in fetus size. All these factors have a physiological impact on all systems of the pregnant woman; musculoskeletal, endocrine, reproductive system, cardiovascular, respiratory, gastrointestinal system, and renal changes.





Thank
you

