BIOCHEMISTRY IN PREGNANCY CONDITIONS

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Advance Clinical Biochemistry II (MA 406)

Summer Semester

Lecture Nine

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Objectives

- **At the end of this lesson, the students should be able to:**
  - The terminologies used in the topic of discussion.
  - The importance of biochemical analysis during pregnancy.
  - The cause of changes in biochemical markers in gestation.
  - The common tests for maternal, placental & fetal conditions
  - The hormonal roles at the gestation period.

Introduction

- Pregnancy induces major physiological, hormonal, and biochemical changes to achieve an optimal outcome for the baby and its mother.
- When it deviates from its normal course, many biochemical markers can be used to assess the abnormalities.
- Imaging (Ultrasonography) in addition to biochemical assessment is important and can be used to assess many placental and fetal abnormalities.

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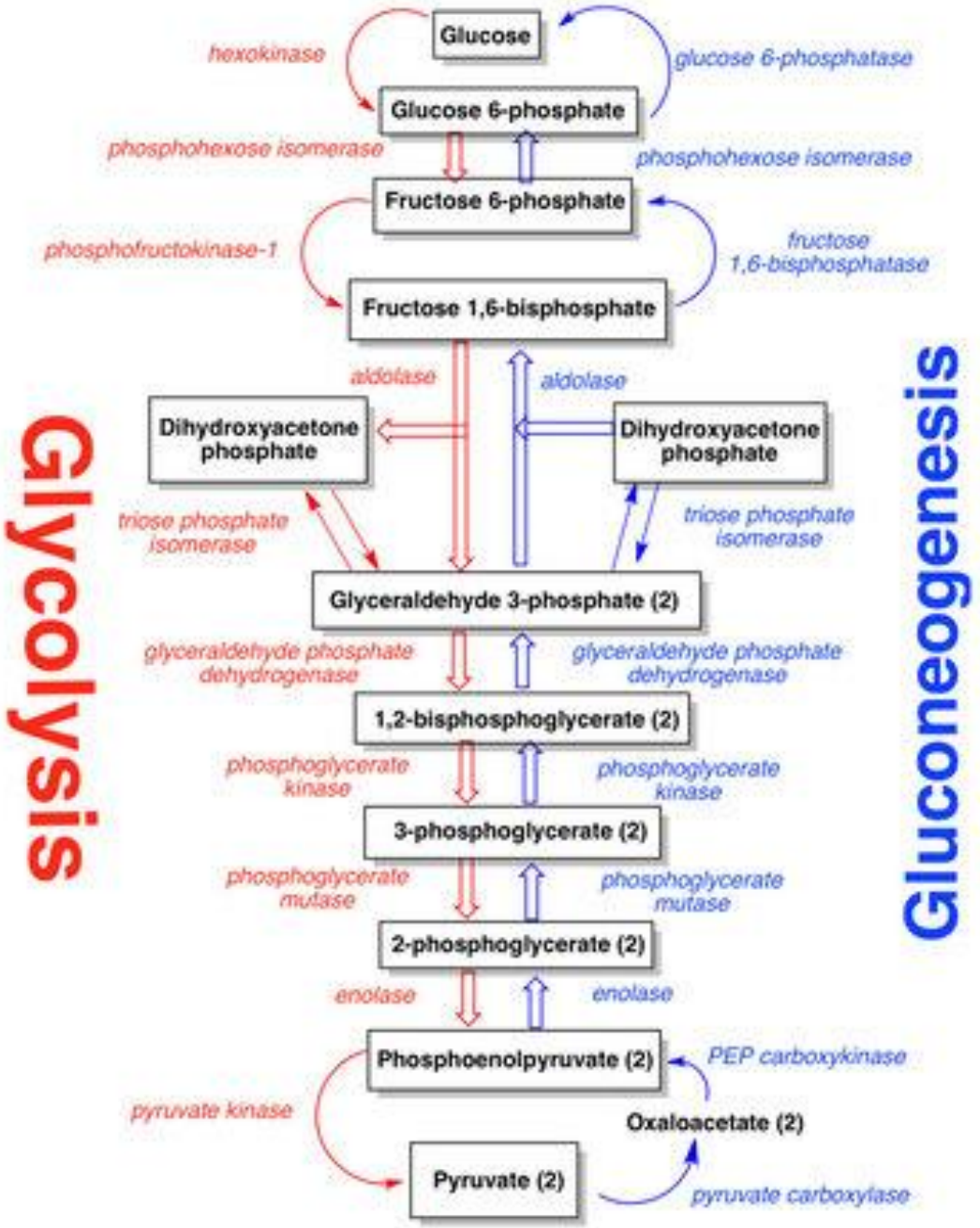
- Ultrasonography continues to improve and be refined in the early detection of fetal structural defects.
- Biochemical markers are used to assess maternal, placental and fetal health.
- They help to diagnose and monitor maternal conditions (gestational diabetes and pre-eclampsia, trophoblastic disease and fetal chromosomal abnormalities such as Down's syndrome).
- These biochemical and hormonal tests constitute only one aspect of obstetric care, and are always better to combine with imaging

Biochemical pathways involved in pregnancy

- During pregnancy, numerous biochemical pathways undergo significant changes to support the growth and development of the fetus and to accommodate the physiological needs of the mother.

- Some of the key biochemical pathways involved in pregnancy include:

- **Glycolysis and Gluconeogenesis**
- **Lipid Metabolism**
- **Amino Acid Metabolism**
- **Iron Metabolism**
- **Calcium Metabolism**
- **Steroid Hormone Biosynthesis**



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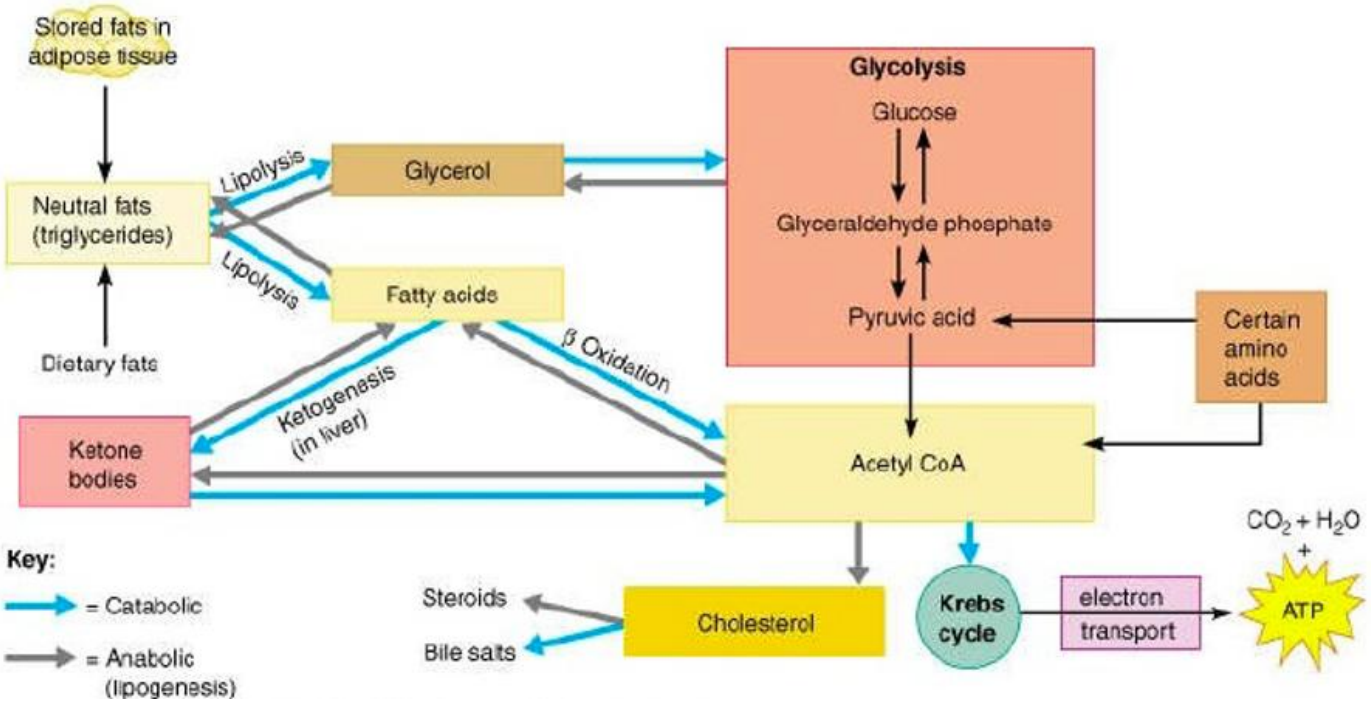
- **Glycolysis and Gluconeogenesis:**

  - During pregnancy, there is an increased demand for glucose to support the energy needs of the growing fetus and maternal tissues.

  - Glycolysis, the breakdown of glucose into pyruvate, is upregulated to provide energy for cellular processes.

  - Additionally, gluconeogenesis, the synthesis of glucose from non-carbohydrate precursors such as amino acids and glycerol, is also increased to maintain blood glucose levels and prevent maternal hypoglycemia.



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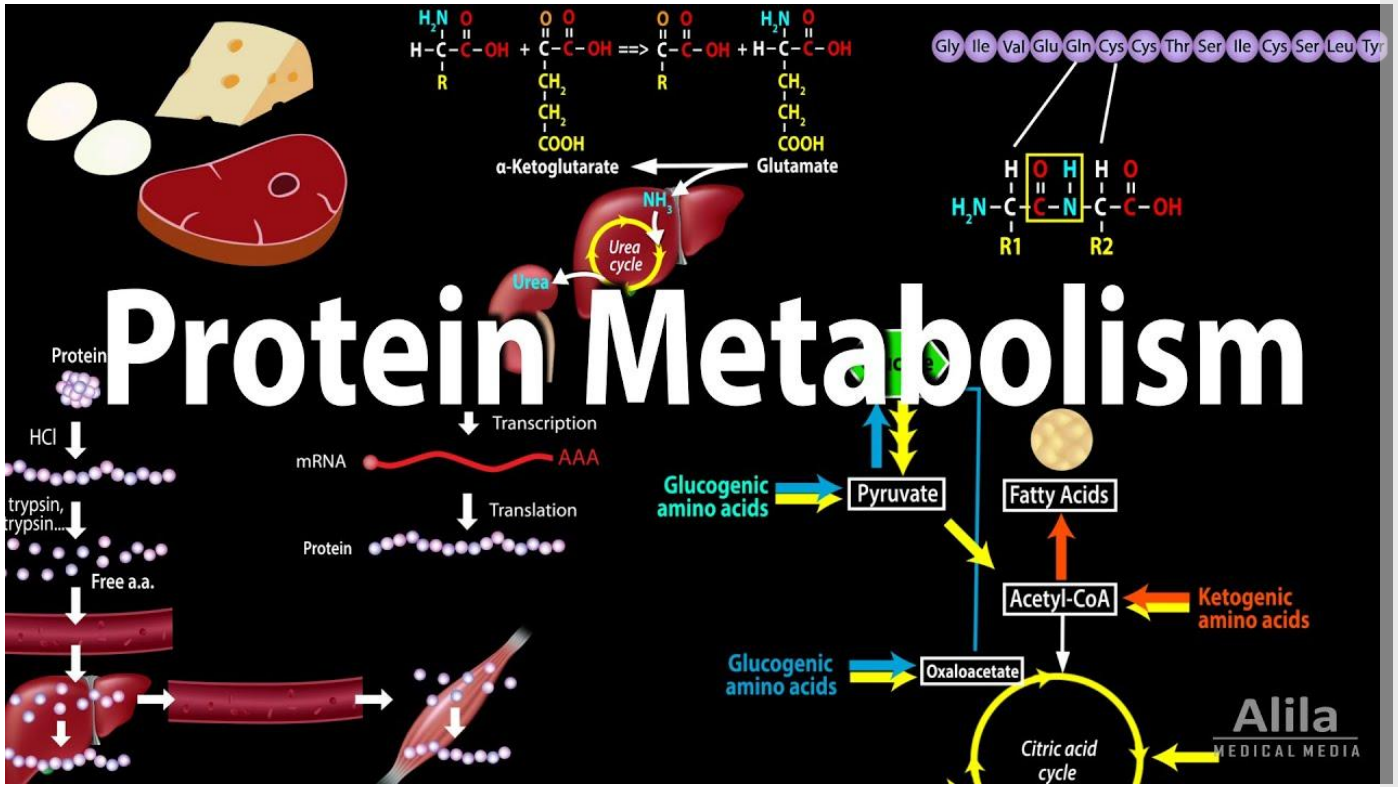
❑ Lipid Metabolism:

- Pregnancy is characterized by changes in lipid metabolism to ensure an adequate supply of fatty acids for fetal growth and development.
- Lipolysis, the breakdown of stored fats into fatty acids and glycerol is enhanced to provide energy for maternal tissues and to supply fatty acids for placental and fetal development.
- Lipogenesis, the synthesis of fatty acids and triglycerides, is also increased to store energy for later use and to support the formation of fetal membranes and adipose tissue.



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- **Amino Acid Metabolism:**

  - Amino acids are essential building blocks for protein synthesis and are crucial for fetal growth and development.

  - During pregnancy, there is increased amino acid uptake by the placenta to support fetal protein synthesis and growth.

  - Maternal amino acid metabolism is also altered to ensure an adequate supply of amino acids for both maternal and fetal tissues.

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❑ Iron Metabolism:

- Iron is required for the synthesis of hemoglobin and is essential for oxygen transport to the fetus and maternal tissues.
- During pregnancy, there is an increase in iron absorption and utilization to meet the demands of the growing fetus.
- It is also required to compensate for the expansion of maternal blood volume.
- Iron metabolism is tightly regulated by hormonal signals, particularly erythropoietin and hepcidin, to ensure adequate iron availability while preventing iron overload.

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❑ Calcium Metabolism:

- Calcium is necessary for fetal bone development, muscle contraction, and nerve function.
- During pregnancy, there is increased calcium absorption from the intestines and increased renal reabsorption to maintain maternal calcium levels and to meet the fetal demand for calcium.
- Hormonal changes, including increased production of calcitriol (active vitamin D) and parathyroid hormone, play crucial roles in regulating calcium metabolism during pregnancy.

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❑ Steroid Hormone Biosynthesis:

- Pregnancy involves a dramatic increase in the production of steroid hormones. It includes estrogen and progesterone essential for maintaining the pregnancy and supporting fetal growth.

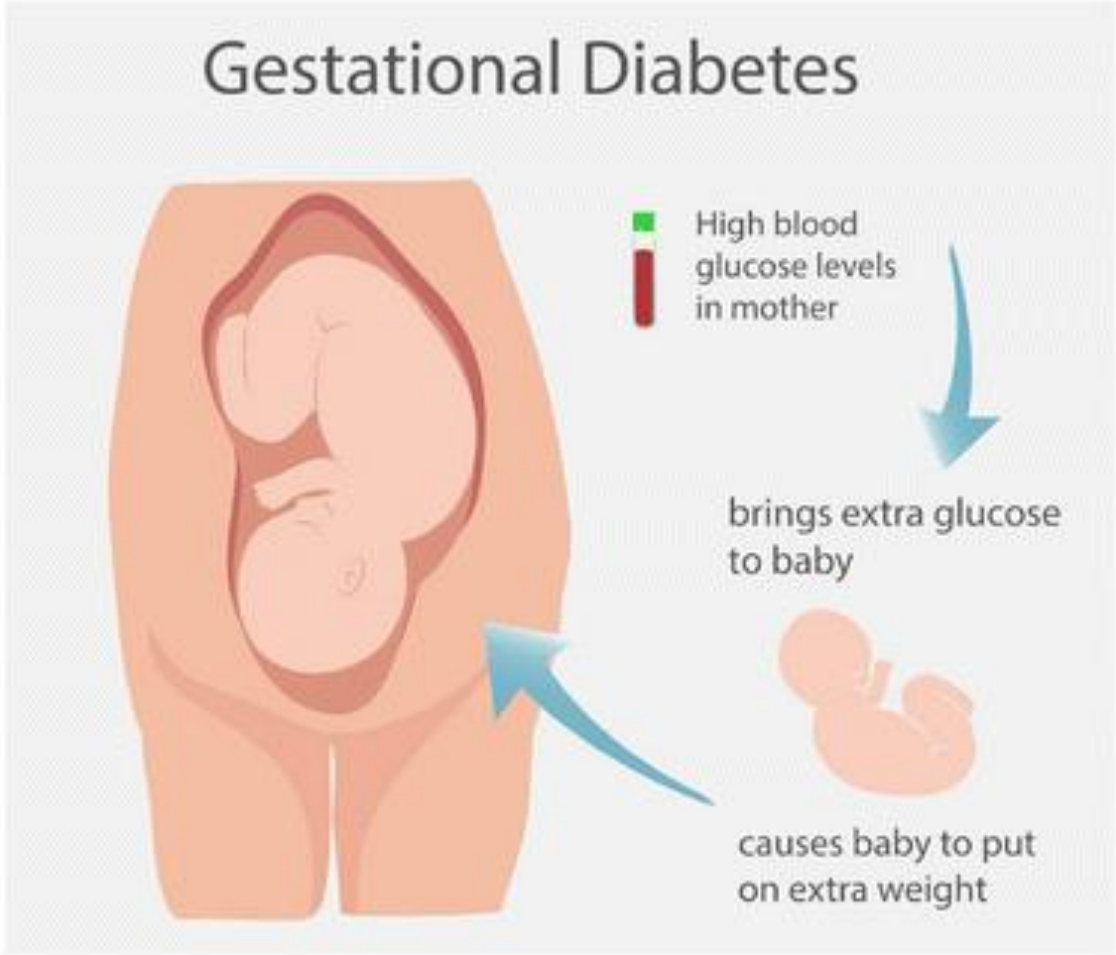
- The hormones are synthesized in the ovaries, placenta, and adrenal glands. They play crucial roles in regulating uterine function, promoting placental development, and preparing the breasts for lactation.

- These biochemical pathways undergo dynamic changes throughout pregnancy to support the unique metabolic and physiological demands of gestation and to ensure the health and well-being of both the mother and the developing fetus.

Biochemical tests for common maternal, placental and fetal conditions

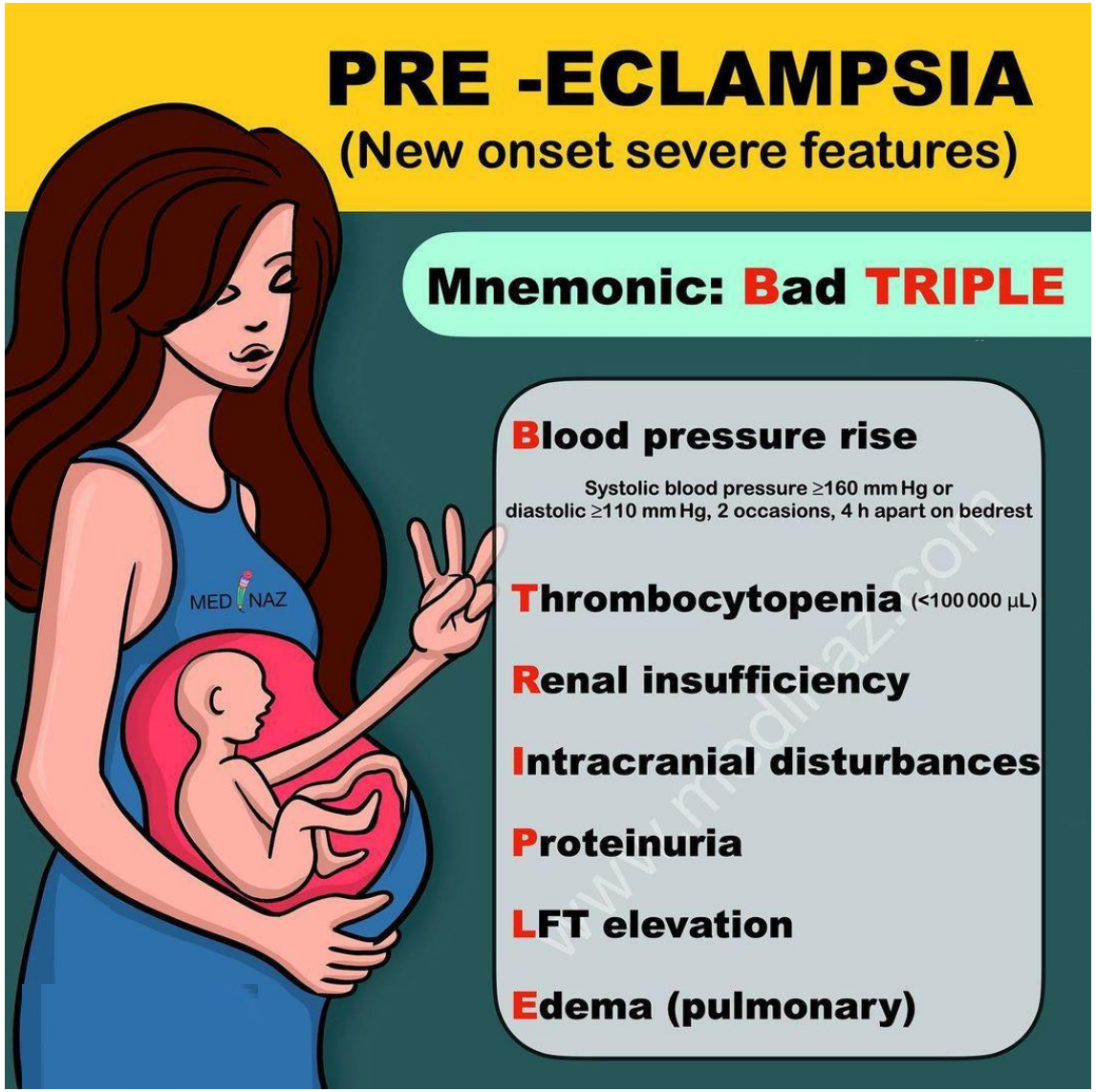
	Condition	Test
Maternal	Gestational diabetes	Glucose screening tests at 24-28 weeks: 50 g challenge test **or** 2-hour 75 g oral glucose tolerance test
	Pre-eclampsia*	1. Urinary protein (by dipstick testing or formal quantitation) 2. Serum uric acid 3. Renal function tests 4. Full blood count (for Hb concentration and platelet count)

Placental	Trophoblastic disease* (hydatidiform mole or choriocarcinoma)	1. HCG 2. Free β-HCG 3. Urinary HCG when indicated
Fetal	Down's syndrome*	Maternal serum alpha fetoprotein, HCG, pregnancy-associated plasma protein-A, and transnuchal ultrasound between 11 and 13 weeks gestation
		Maternal serum alpha fetoprotein, HCG, pregnancy-associated plasma protein-A, and serum unconjugated oestriol in various combinations between 15 and 18 weeks gestation
	Neural tube defects	1. Maternal serum alpha fetoprotein **or** 2. Amniotic fluid alpha fetoprotein (less common)



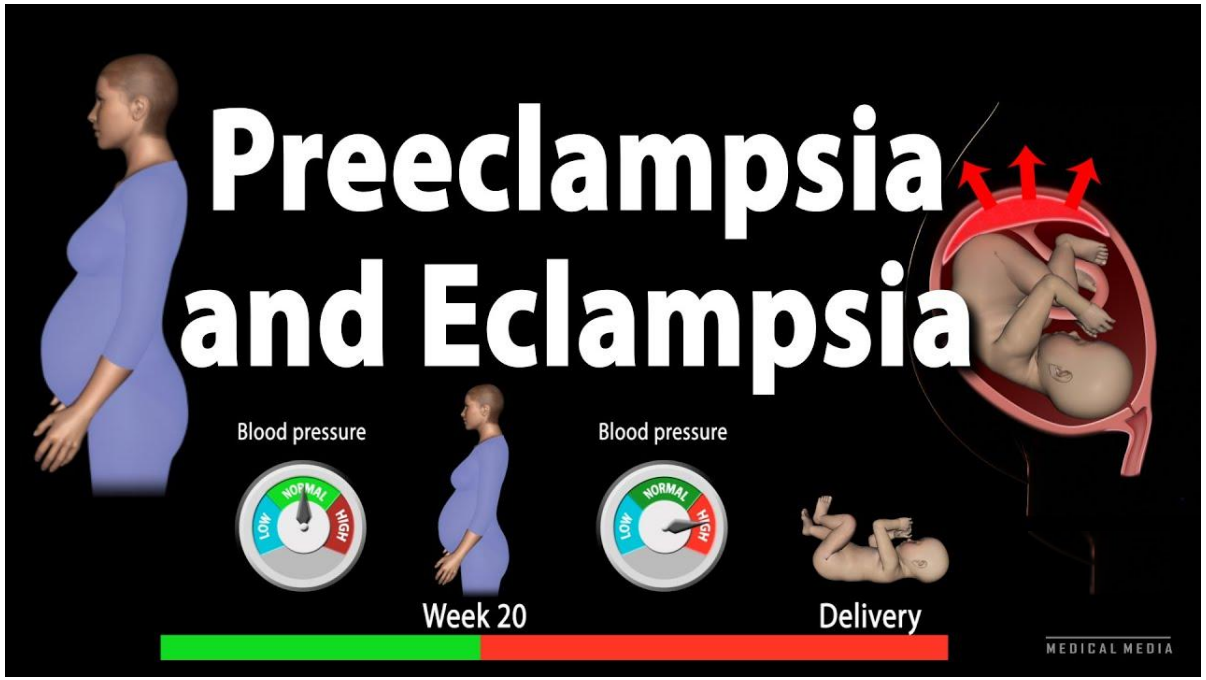
Biochemical assessment of maternal health: Gestational Diabetes (GD)

- Screening for gestational diabetes is strongly advocated at 26-28 weeks of gestation, to enable early intervention and care.
- Occasionally, serum glucose is found to be in the diabetic range in the first trimester.
- No difference between diabetes that preceded and gestational diabetes.
- The diagnosis can be confirmed by further tests of fasting glucose or a 75 g oral glucose tolerance test.



Pre-eclampsia

- A medical condition occurs typically in the third trimester and affects 4-8% of pregnancies.
- It is characterized by pregnancy-associated non-preexisting hypertension marked by proteinuria (>300 mg daily) and pathological oedema.
- It is critical to have qualitative or quantitative urinary tests for protein, Blood Pressure measurement, and examination for oedema at each antenatal.
- Other findings include rises in serum uric acid (which can occur before the onset of hypertension), urea & creatinine.



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- Low hemoglobin and platelet conc. are informative if the patient is suspected to have a severe form of pre-eclampsia.
- In the absence of pre-existing pathology, these biochemical parameters should return to normal after delivery.

Biochemical assessment of placental health

- Maternal serum human placental lactogen and serum or urinary oestriol concentrations are used extensively in the assessment of placental function
- Ultrasonography has added another dimension to first-trimester obstetric care, by providing real-time information about fetal status.

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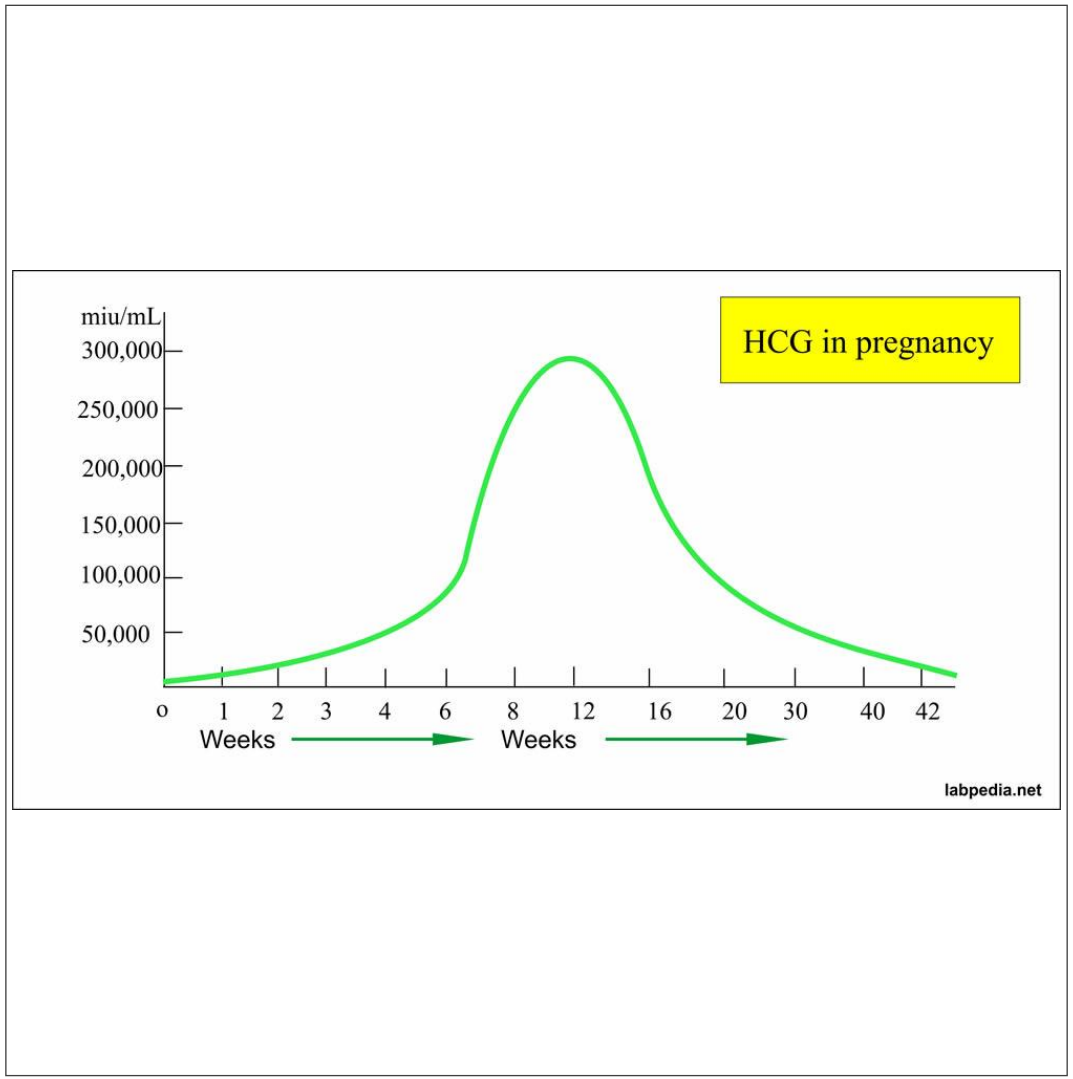
❑ *Human chorionic gonadotrophin (hCG)*

As pregnancy progresses, the patient's hormonal profile continues to evolve with steadily rising concentrations of progesterone and estrogen.

- These continue to rise well into the first trimester while conc. of luteinizing hormone and follicle-stimulating hormone are low or suppressed.
- To maintain progesterone production from the corpus luteum to keep the pregnancy viable in its early stage, the placenta starts to secrete hCG.
- The serum hCG is therefore the test of choice for confirming pregnancy.



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- Physiologically, serum hCG arising from trophoblastic activity is elevated as early as the eighth day after implantation.
- Concentrations double every 2-3 days and peak at approximately 10 weeks.
- They then decline and plateau out at a lower concentration until parturition

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- In addition to confirming pregnancy, serum HCG can be used as a marker to assess various abnormalities in the first trimester.
- A failure to rise at the appropriate rate suggests the impending loss of the pregnancy from spontaneous miscarriage or an unviable pregnancy.
- A markedly elevated serum HCG suggests the presence of multiple pregnancies, especially with assisted fertilization, or the presence of gestational trophoblastic disease
- Confirmatory biochemical tests should include the freeβ-HCG conc. because this form of HCG is secreted in disproportionately high amounts.

Activities

- What is the essence of the induction of physiological, hormonal, and biochemical alterations during pregnancy?
- Biochemical markers can be used to assess abnormalities when pregnancy deviates from its normal course. **True/False?**
- What is the importance of Ultrasonography at the gestational period?
- What are the recommended biochemical test(s) for the maternal health condition during pregnancy?
- What are the recommended biochemical test(s) for the placental health condition during pregnancy?
- Differentiate between gestational diabetes and pre-eclampsia in terms of biochemical testing.
- Describe the role of hCG in the biochemical assessment of placental health.

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