



REPRODUCTIVE PHYSIOLOGY LECTURE 5

PHYSIOLOGY OF PREGNANCY

GUYTON & HALL, Chapter 83

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OBJECTIVES

By the end of this lecture, you should be able to:

- Recognize the placenta as an endocrine organ
- Describe the physiological functions of placental hormones
- Explain the mother's physiological response to pregnancy

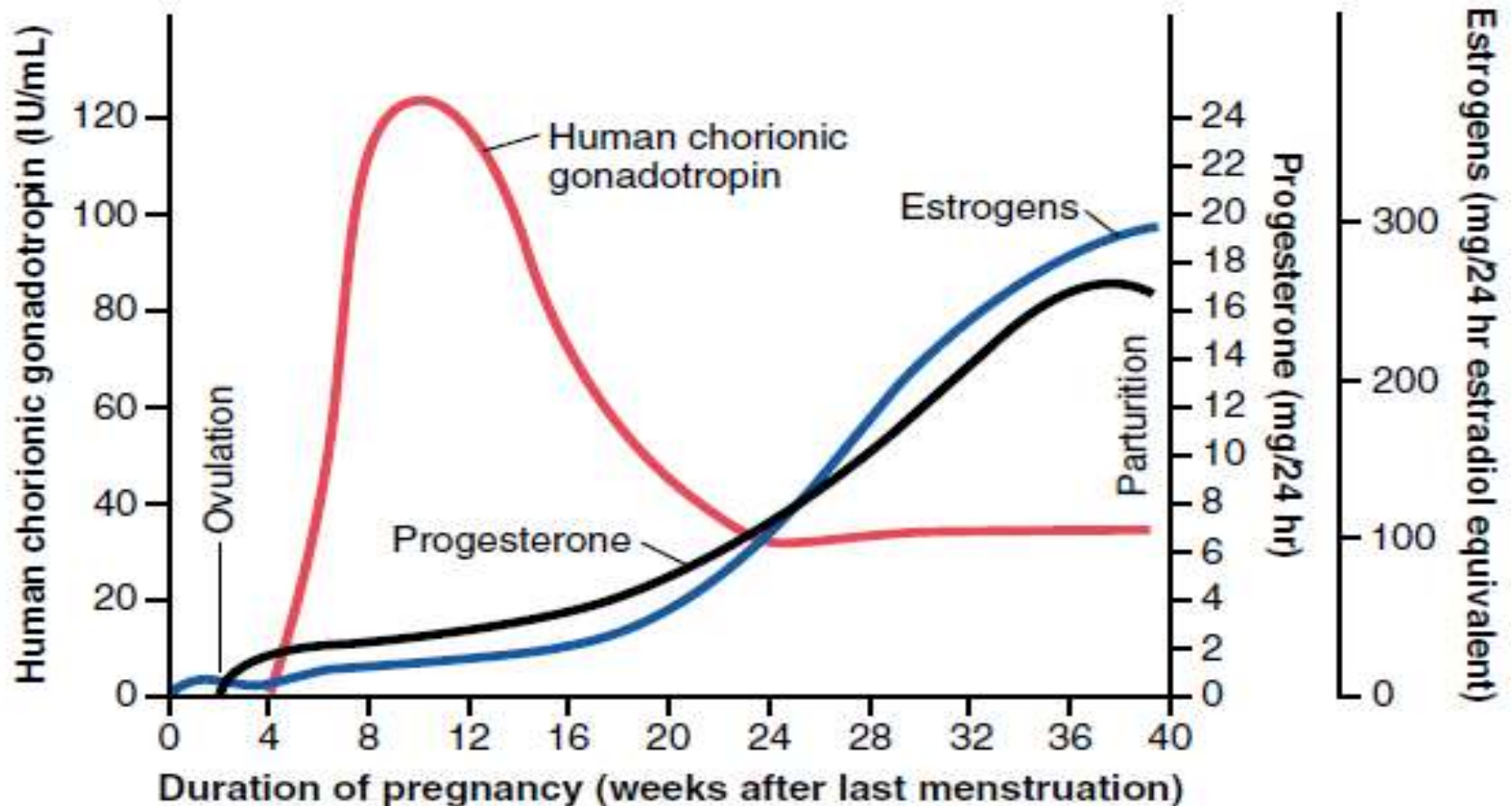
PLACENTA AS ENDOCRINE ORGAN

- Human Chorionic Gonadotropin (hCG)- glycoprotein
- Menstrual sloughing is prevented by the secretion of human chorionic gonadotropin by the newly developing embryonic tissues
- first measured in the blood 8 to 9 days after ovulation,(blastocyst implants)Then max at ~ 10 weeks of pregnancy and decreases back to low by 16 to 20 weeks till the remainder of the pregnancy.
- Secreted by syncytial trophoblast cells
- Most important function is to maintain corpus luteum (↑estrogen & progesterone) till 13-17 weeks of gestation; decidual cells—greatly swollen and nutritious
- Exerts interstitial (Leyding) cell-stimulating effect on testes of the male fetus (growth of male sex organs) by production of testosterone in male fetuses until birth.
- corpus luteum involutes slowly after the 13th to 17th week of gestation.

Q

- What if corpus leutium was removed before 7th week of pregnancy?

HCG LEVEL (PREGNANCY TEST)



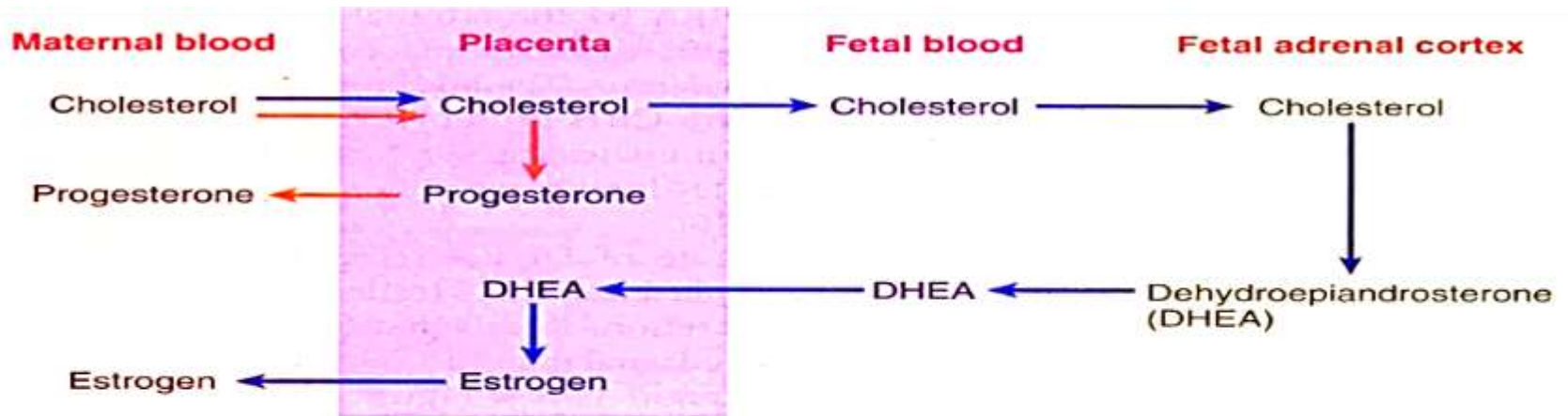
PLACENTA AS ENDOCRINE ORGAN

- Estrogen
 - Secreted by syncytial trophoblast cells of placenta
 - Towards the end of pregnancy it reaches 30×
 - Derived from weak androgen (DHEA) released from maternal & fetal adrenals cortex
 - 30 times the mother's normal level
- Functions in the mother
 - Enlargement of uterus, breast (and ductal) & external genitalia
 - Relaxation of pelvic ligaments in preparation for labor(sacroiliac joints, symphysis pubis)
 - Activation of the uterus (gap junctions)

PLACENTA AS ENDOCRINE ORGAN

PROGESTERONE

- Progesterone is essential for a successful pregnancy;
- moderate quantities by the corpus luteum at the beginning of pregnancy
- later in large quantities by the placenta(10X), by syncytial trophoblast cells from cholesterol.
- Effects of progesterone in pregnancy:
 1. Progesterone causes decidual cells to develop in the uterine endometrium (nutrition of the early embryo)
 2. Progesterone decreases the contractility of the pregnant uterus, thus preventing spontaneous abortion.
 3. Progesterone contributes to the development of the conceptus before implantation(secretions of the mother's fallopian tubes and uterus to provide nutrition for the developing morula and blastocyst).
 4. believed that progesterone affects cell cleavage in the early developing embryo.
 5. helps estrogen prepare the mother's breasts for lactation



KEY

- Orange arrow: Pathway for placental synthesis of progesterone
- Blue arrow: Pathway for placental synthesis of estrogen

- FIGURE 20-31 Secretion of estrogen and progesterone by the placenta.** The placenta secretes increasing quantities of progesterone and estrogen into the maternal blood after the first trimester. The placenta itself can convert cholesterol into progesterone (*orange pathway*) but lacks some of the enzymes necessary to convert cholesterol into estrogen. However, the placenta can convert DHEA derived from cholesterol in the fetal adrenal cortex into estrogen when DHEA reaches the placenta by means of the fetal blood (*blue pathway*).

PLACENTA AS ENDOCRINE ORGAN

- Human Chorionic Somatomamotropin or Human placental lactogen (hPL)
 - Protein hormone
 - Secreted by placenta around 5th gestational week
 - quantities several times greater than that of all the other pregnancy hormones combined
- Functions in the mother (not all well known)
 - Breast development (cant induce milk in human)
 - Weak growth hormone's action(100x less)
 - Inhibits insulin sensitivity =↓ glucose utilization by mother
 - Promotes release of fatty acids (source of energy)
 - Mainly metabolic actions

PLACENTA AS ENDOCRINE ORGAN

- Relaxin
 - Polypeptide
 - Secreted by corpus luteum and placenta
- Functions in the mother
 - Relaxation of symphysis pubic ligament (weak effect)
 - Softens the cervix at delivery
 - vasodilator (may increase blood flow, venous return and cardiac output)

CHANGES IN MATERNAL ENDOCRINE SYSTEM

- due to maternal metabolic load and response to placenta hormones
- Anterior pituitary gland enlargement (50%)
 - Release of ACTH, TSH and PL (corticotropin, thyrotropin, and prolactin)
 - FSH and LH almost totally suppressed (?)
- Adrenal gland
 - Increase glucocorticoids secretion (mobilize aminoacids)
 - Increase aldosterone(2X) (retain fluid) pregnancy-induced hypertension
- Thyroid gland enlargement (50%) thyroxine production
- thyrotropic effect of hcG and TSH, and placenta human chorionic thyrotropin
- Parathyroid gland enlargement
 - Increase PTH secretion (maintain normal Ca^{+2}) to ossify bones of fetus

CHANGES IN DIFFERENT ORGANS

- Increase in uterine size (50 gm to 1100 gm)
- The breasts double in size
- The vagina enlarges
- Development of edema and acne
- Masculine or acromegalic features
- Weight gain 10-12 kg (last 2 trimesters)(~4kg fetus)
 - Increase appetite
 - Removal of nutrients by fetus
 - Hormonal effect

METABOLISM

- Increase basal metabolic rate (15%) due to thyroxine ACTH sex hormones
- Increase in daily requirements for
 - Iron
 - Phosphates
 - Calcium
 - Vitamins - vitamin D (Ca^{+2} absorption)

KIDNEY FUNCTION DURING PREGNANCY

- The renal tubules' reabsorption capacity for sodium, chloride, and water is increased as much as 50%
 - cortical and placenta steroid hormones
 - The renal blood flow and GFR increase up to 50%
 - Tubuloglomerular feed back
 - NO or relaxin
- Normal pregnant woman accumulates only about ~2.5 kg of extra water and salt. Excreted after delivery

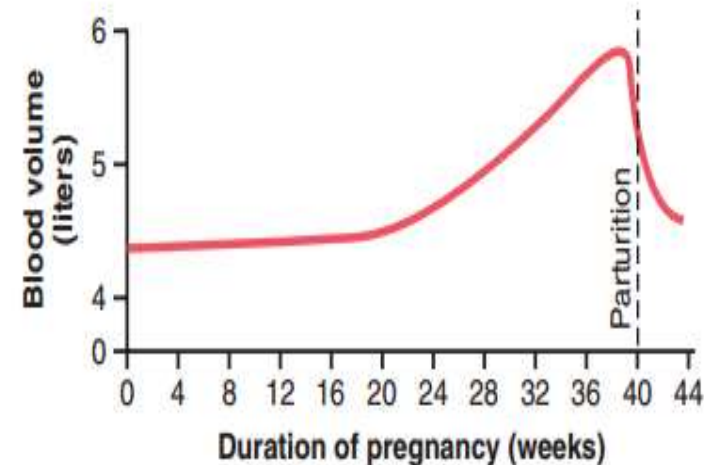
CHANGES IN CIRCULATORY SYSTEM

- Increase in blood flow through the placenta, 625 ml/min
- Increase in maternal blood volume (30%) due to
 - Increase aldosterone and estrogen (\uparrow ECF)
 - Increase activity of the bone marrow (\uparrow RBCs)
 - (1-2 L extra-safety factor)

■ Blood Flow and Cardiac Output Increase

During Pregnancy (30-40%) by 27th weeks.

- Due to increased metabolism and blood flow
- the cardiac output falls in the last 8 weeks of pregnancy, blood flow in
 - blood flow in some other tissue(s) may be reduced.



CHANGES IN RESPIRATION

- Increase in O_2 consumption (20%)
 - Increase Basal Metabolic Rate
 - Increase in body size
- Increase in respiratory rate (RR)
 - Progesterone \uparrow sensitivity of respiratory center to CO_2
 - the growing uterus presses upward against the abdomen, which presses upward against the diaphragm, so the total excursion of the diaphragm is decreased. Thus respiratory rate is increased to maintain the extra ventilation
- Increase in minute ventilation by 50% and a decrease in arterial PCO_2 to several ml

AMNIOTIC FLUID

- Normally, the volume of amniotic fluid 500ml-1L
- The water in amniotic fluid is replaced once every 3 hours and the electrolytes sodium and potassium are replaced an average of once every 15 hours.
- A large portion of the fluid is derived from renal excretion by the fetus.
- Some absorption occurs by way of the gastrointestinal tract and lungs of the fetus.
- amniotic membranes contribute to formation and absorption



PREECLAMPSIA

- 5 % of all pregnant women experience pregnancy-induced hypertension,
- a rapid rise in arterial blood pressure to hypertensive levels during the last few months of pregnancy
- associated with proteinuria. Excess salt and water retention by the mother's kidneys
- Weight gain, edema and hypertension in the mother.
- Vascular endothelial function is impaired and arterial spasm occurs in many parts of the mother's body, kidneys, brain, and liver
- Renal blood flow and the glomerular filtration rate are decreased
- Mechanism: excessive secretion of placental or adrenal hormones ?? some type of autoimmunity or allergy in the mother caused by fetus
- Evidence : Preeclampsia is initiated by insufficient blood supply to the placenta, resulting in the placenta's release of substances that cause widespread dysfunction. (maternal arterioles fail to undergo adaptive changes).
- a role for increased levels of inflammatory cytokines such as TNF- α and IL-6.
- Placental factors that impede angiogenesis (blood vessel growth)

ECLAMPSIA

- Eclampsia is an extreme degree of preeclampsia
- Vascular spasm throughout the body;
- Clonic seizures in the mother, sometimes followed by coma;
- Decreased kidney output (greatly);
- Liver malfunction;
- Extreme hypertension;
- A generalized toxic condition of the body.
- usually occurs shortly before the birth of the baby.
- Without treatment, a high percentage of mothers with eclampsia die.
- However, with optimal and immediate use of rapidly acting vasodilating drugs, followed by immediate termination of pregnancy the mortality is reduced to 1% or less.