estrone. Generally, hormone production by the placenta increases in proportion to the increase in placental mass. Therefore concentrations of hormones derived from the placenta, such as PL, increase in maternal peripheral blood as the placenta increases in size. CG, which peaks at the end of the first trimester, is an exception.

Chorionic Gonadotropin

CG is a very important placental hormone. It stimulates the ovary to produce progesterone which, in turn, prevents menstruation thereby protecting the pregnancy. The chemistry, biochemistry, and methods for CG are discussed later in this chapter.

Placental Lactogen

PL, also known as human placental lactogen (hPL) and human chorionic somatomammotropin (hCS), is a single polypeptide chain of 191 amino acids. The structure of PL is exceptionally homologous (96%) with growth hormone (GH) and less so with prolactin (67%). It has potent growth and lactogenic properties. The placental secretion near term is 1 to 2 g/day, the largest of any known human hormone. From the physiological point of view, PL has many biological activities, including (1) lactogenic, (2) metabolic, (3) somatotropic, (4) luteotropic, (5) erythropoietic, and (6) aldosterone-stimulating effects. Either directly or in synergism with prolactin, PL has a significant role in preparing the mammary glands for lactation. Although PL was used in the past to evaluate fetal well-being, currently no apparent clinical reason exists to measure PL.

Placental Steroids

The placenta produces a wide variety of steroid hormones, including estrogen and progesterone. Phenomenal amounts of estrogens are produced at term. The chemistry of these steroids is described in Chapter 42. Maternal cholesterol is the main precursor for placental progesterone production. Biosynthesis of estrogens by the placenta differs from that of the ovaries because the placenta has no 17α-hydroxylase. Thus each of the estrogens—(1) estrone (E_1), (2) estradiol (E_2), and (3) estriol (E_3)—must be synthesized from C_{19} intermediates that already have a hydroxyl group at position 17. In nonpregnant women, the ovaries secrete 100 to 600 μg/day of estradiol, of which about 10% is metabolized to estrone. During late pregnancy, the placenta produces 50 to 150 mg/day of estriol and 15 to 20 mg/day of estradiol and estrone. The secretion of estrogens and progesterone throughout pregnancy ensures (1) appropriate development of the endometrium, (2) uterine growth, (3) adequate uterine blood supply, and (4) preparation of the uterus for labor. Although measurement of estriol in the third trimester was used in the past to assess fetal well-being, many obstetricians consider this practice obsolete. Estriol measurements at 16 to 18 weeks gestational age are useful in predicting fetal trisomy 21 and 18 (see later discussion on maternal serum screening for fetal defects).

Amniotic Fluid

Throughout intrauterine life, the fetus lives within a fluid-filled compartment. The **amniotic fluid** provides a medium in which the fetus readily moves; it cushions a fetus against possible injury and helps maintain a constant temperature.

The volume of amniotic fluid is (1) 200 to 300 mL at 16 weeks, (2) 400 to 1400 mL at 26 weeks, (3) 300 to 2000 mL at 34 weeks, and (4) 300 to 1400 mL at 40 weeks. The volume at any given moment is a function of several interrelated fluid movements, including fetal (1) swallowing, (2) urination, (3) intramembranous transport, and (4) pulmonary excretion. Although the fetal lung fluid contributes a small volume, fetal breathing of this fluid is the mechanism of surfactant transport from the fetal lungs into the amniotic fluid.

Pathological decreases and increases of amniotic fluid volume are encountered frequently in clinical practice. Intrauterine growth retardation and abnormalities of the fetal urinary tract, such as bilateral renal agenesis or obstruction of the urethra, are associated with *oligohydramnios*, an abnormally low amniotic fluid volume. Increased fluid volume is known as *hydramnios* (also termed *polyhydramnios*). Conditions associated with hydramnios are as diverse as maternal diabetes mellitus, including (1) severe Rh isoimmune disease, (2) fetal esophageal atresia, (3) multifetal pregnancy, (4) anencephaly, and (5) spina bifida.

Early in gestation, the composition of the amniotic fluid resembles a complex dialysate of the maternal serum. As a fetus grows, the amniotic fluid changes in several ways (Table 43-1). Most notably, the sodium concentration and osmolality decrease and the concentrations of urea, creatinine, and uric acid increase. The major lipids of interest are the phospholipids, whose type and concentrations reflect fetal lung maturity (discussed further later). Numerous steroid and protein hormones are also present in amniotic fluid and some are useful for diagnosing congenital adrenal hyperplasia (CAH) and fetal thyroid disease.

Early in pregnancy, there is little or no particulate matter in the amniotic fluid. By 16 weeks of gestation, large numbers of cells are present, having been shed from the surfaces of the amnion, skin, and tracheobronchial tree. These cells are of great utility in antenatal diagnosis. As pregnancy continues to progress, scalp hair and *lanugo* (fine hair on the body of the fetus) are also shed into the fluid and contribute to its turbidity. The production of surfactant particles in the lung, termed *lamellar bodies*, greatly increases the haziness of the fluid. At

TABLE 43-1 Composition of Amniotic Fluid (Mean Values)

	Gestational Age (wk)		
Component	**15**	**25**	**40**
Sodium, mmol/L	136	138	126
Potassium, mmol/L	3.9	4.0	4.3
Chloride, mmol/L	111	109	103
Bicarbonate, mmol/L	16	18	16
Urea nitrogen, mg/dL	11	11	18
Creatinine, mg/dL	0.8	0.9	2.2
Glucose, mg/dL	47	39	32
Uric acid, mg/dL	4.0	5.7	10.4
Total protein, g/dL	0.5	0.8	0.3
Bilirubin, mg/dL	0.13	0.14	0.04
Osmolality, mOsm/kg H_2O	272	272	255

From Benzie RJ, Doran TA, Harkins JL, Owen VM, Porter CJ. *Composition of the amniotic fluid and maternal serum in pregnancy. Am J Obstet Gynecol* 1974;119:798-810.