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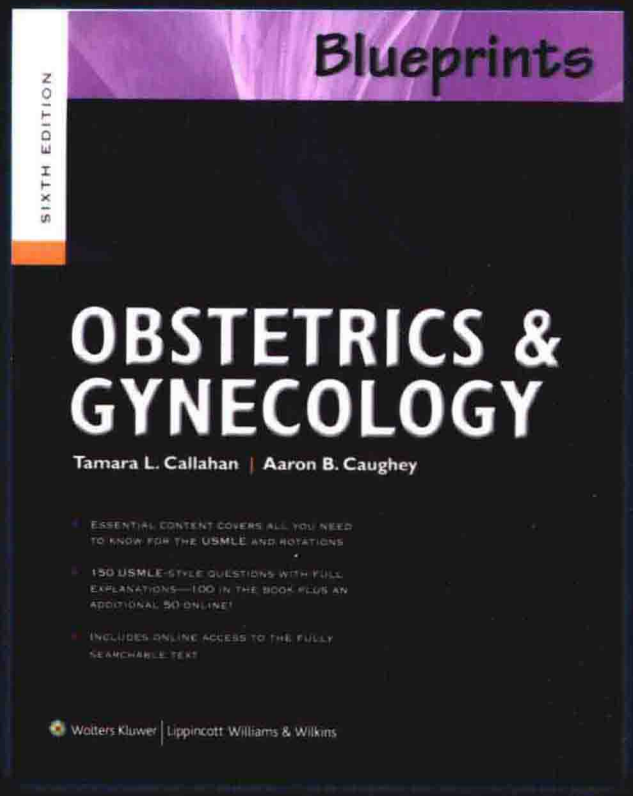
OBSTETRICS & GYNECOLOGY

(Sixth Edition)

妇产科学

(第 6 版)

Tamara L. Callahan
Aaron B. Caughey



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OBSTETRICS & GYNECOLOGY

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妇产科学

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Preface

In 1997, the first five books in the Blueprints series were published as board review for medical students, interns, and residents who wanted high-yield, accurate clinical content for USMLE Steps 2 and 3. Fifteen years later, we are proud to report that the original books and the entire Blueprints brand of review materials have far exceeded our expectations.

The feedback we've received from our readers has been tremendously helpful and pivotal in deciding what direction the sixth edition of the core books would take. To ensure that the sixth edition of the series continues to provide the content and approach that made the original Blueprints a success, we have expanded the text to include the most up-to-date topics and evidence-based research and therapies. Information is provided on the latest changes in the management of cervical dysplasia and cervical cancer screening, abnormal uterine bleeding, hypertension in pregnancy, cervical insufficiency, and preterm labor. The newest and future techniques in contraception and sterilization and hormone replacement therapies are covered, as are contemporary treatment options for uterine fibroids and invasive breast cancer.

The succinct and telegraphic use of tables and figures was highly acclaimed by our readers, so we have redoubled our efforts to expand their usefulness by adding updated and improved artwork, including the section of color plates. In each case, we have tried to include only the most helpful and clear tables and figures to maximize the reader's ability to understand and remember the material.

We have likewise updated our bibliography to include evidence-based articles as well as references to classic articles and textbooks in both obstetrics and gynecology. These references are now provided in electronic format. It was also suggested that the review questions should reflect the current format of the boards. We are particularly proud to include new and revised board-format questions in this edition with full explanations of both correct and incorrect options provided in the answers. In particular, we have added a section of case-based clinical vignettes questions at the end of each chapter to facilitate review of the topics and practice for the boards.

That said, we have also learned from our readers that Blueprints is more than just board review for USMLE Steps 2 and 3. Students use the books during their clerkship rotations, subinternships, and as a quick refresher while rotating on various services in early residency. Residents studying for USMLE Step 3 often use the books for reviewing areas outside their specialty. Students in physician assistant, nurse practitioner, and osteopath programs use Blueprints as a companion to review materials in their own areas of expertise.

When we first wrote the book, we had just completed medical school and started residency training. Thus, we hope this new edition brings both that original viewpoint as well as our clinical experience garnered over the past 15 years. However you choose to use Blueprints, we hope that you find the books in the series informative and valuable to your own continuing education.

Tamara L. Callahan, MD, MPP
Aaron B. Caughey, MD, MPP, MPH, PhD

Acknowledgments

I would like to express my sincere and deep appreciation to my coauthor, Dr. Caughey, and to the OB/Gyn residents and faculties at Harvard and Vanderbilt who gave liberally of their time and expertise to make this book something of which we can all be proud. Without the extraordinary talent and commitment of these physicians and providers, this project would not have been possible. This accomplishment is also credited in no small part to an incredible core of family and friends who lovingly and selflessly allow me to follow my passion for education and women's health. And to my children, Connor and Jaela, being your mother has been an indescribable honor and an immeasurable joy—a blessing which I try to earn each and every day. I would also like to acknowledge my mentors, Dr. William F. Crowley, Jr., Dr. Janet Hall, Dr. Linda J. Heffner, Dr. Nancy Chescheir, Dr. Robert Barbieri, and Dr. Nancy E. Oriol, whose strength, insight, leadership, and drive are exemplary of what it means to be an active contributor to academic medicine and women's health. Lastly, I'd like to thank the many medical students and residents who have shared their input and enthusiasm with us along this exciting journey. Their support has been paramount to the success of this project and to our quest to make this book the very best it can be. It has truly been a privilege to be a small part of their never-ending learning experience.

Tamara L. Callahan, MD, MPP

I would like to acknowledge and extend my thanks to everyone involved in the sixth edition of our book, most importantly my coauthor, Dr. Callahan, as well as all of those who contributed to the first five editions, particularly Drs. Chen, Feinberg, and Heffner, and the staff at both Blackwell and LWW. I would also like to thank my colleagues and mentors for the supportive environment in which I work, in particular, the residents and faculty in the department of Obstetrics and Gynecology at OHSU as well as my mentors, Drs. Washington, Norton, Kuppermann, Ames, Repke, Blatman, Robinson, and Norwitz. I would also like to acknowledge the suggestions and critiques from medical students around the country and particularly those at Harvard, UCSF, and OHSU who keep pushing us to produce better editions of this work. I would also like to thank my parents, Bill and Carol, for their support for all these years. To my children, Aidan, Ashby, Amelie, and our little man, Atticus—and of course, to my wife, Susan— thank you for all your patience and support during all my projects. I love you all so very much.

Aaron B. Caughey, MD, MPP, MPH, PhD

Abbreviations

3β-HSD	3β-hydroxysteroid dehydrogenase
5-FU	5-fluorouracil
17α-OHP	17α-hydroxyprogesterone
ACTH	adrenocorticotropic hormone
AD	autosomal dominant
ADH	antidiuretic hormone
AED	antiepileptic drug
AFE	amniotic fluid embolus
AFI	amniotic fluid index
AFLP	acute fatty liver of pregnancy
AFP	α-fetoprotein
AGC	atypical glandular cells
AIDS	acquired immunodeficiency syndrome
ALT	alanine transaminase
AMA	advanced maternal age
AMH	Antimullerian Hormone
APA	antiphospholipid antibody
AR	autosomal recessive
ARDS	adult respiratory distress syndrome
AROM	artificial rupture of membranes
ART	assisted reproductive technology
ASC	atypical squamous cells
ASC-H	atypical squamous cells cannot exclude high-grade squamous intraepithelial lesion
ASC-US	atypical squamous cells of undetermined significance
AST	aspartate transaminase
AV	arteriovenous
AZT	analogs—zidovudine
β-hCG	beta human chorionic gonadotropin
BID	twice a day
BP	blood pressure
BPP	biophysical profile
BUN	blood urea nitrogen
BV	bacterial vaginosis
CAH	congenital adrenal hyperplasia
CBC	complete blood count
CCCT	clomiphene citrate challenge test
CF	cystic fibrosis
CHF	congestive heart failure
CIN	cervical intraepithelial neoplasia
CKC	cold-knife conization (biopsy)
CMV	cytomegalovirus
CNS	central nervous system
CPD	cephalopelvic disproportion
CRS	congenital rubella syndrome
CSF	cerebrospinal fluid
CT	computed tomography (CAT scan)
CVA	cerebrovascular accident
CVAT	costovertebral angle tenderness
CVD	collagen vascular disorders
CVS	chorionic villus sampling
CXR	chest x-ray
DA	developmental age
D&C	dilation and curettage
D&E	dilation and evacuation
DCIS	ductal carcinoma in situ
DES	diethylstilbestrol
DEXA	dual-energy x-ray absorptiometry
DHEA	dehydroepiandrosterone
DHEAS	dehydroepiandrosterone sulfate
DHT	dihydrotestosterone
DIC	disseminated intravascular coagulation
DMPA	depot medroxyprogesterone acetate (Depo-Provera)
DTRs	deep tendon reflexes
DUB	dysfunctional uterine bleeding
DVT	deep venous thrombosis
ECG	electrocardiogram
EDC	estimated date of confinement
EDD	estimated date of delivery
EFW	estimated fetal weight
EIF	echogenic intracardiac focus
ELISA	enzyme-linked immunosorbent assay
EMB	endometrial biopsy
ERT	estrogen replacement therapy
ESR	erythrocyte sedimentation rate
FAS	fetal alcohol syndrome
FH	fetal heart
FHR	fetal heart rate
FIGO	International Federation of Gynecology and Obstetrics
FIRS	fetal immune response syndrome
FISH	fluorescent in situ hybridization
FNA	fine-needle aspiration
FSE	fetal scalp electrode
FSH	follicle-stimulating hormone
FTA-ABS	fluorescent treponemal antibody absorption
FTP	failure to progress
G	gravidity
GA	gestational age
GBS	group B *streptococcus*

GDM	gestational diabetes mellitus
GFR	glomerular filtration rate
GH	gestational hypertension
GI	Gastrointestinal
GLT	glucose loading test
GnRH	gonadotropin-releasing hormone
GTD	gestational trophoblastic disease
GTT	glucose tolerance test
GU	genitourinary
HAART	highly active antiretroviral therapy
Hb	hemoglobin
HbH	hemoglobin H disease
hCG	human chorionic gonadotropin
hCS	human chorionic somatomammotropin
Hct	hematocrit
HDL	high-density lipoprotein
HELLP	hemolysis, elevated liver enzymes, low platelets
HIV	human immunodeficiency virus
hMG	human menopausal gonadotropin
HPL	human placental lactogen
HPV	human papillomavirus
HR	heart rate
HRT	hormone replacement therapy
HSG	hysterosalpingogram
HSIL	high-grade squamous intraepithelial lesion
HSV	herpes simplex virus
I&D	incision and drainage
ICSI	intracytoplasmic sperm injection
Ig	Immunoglobulin
IM	Intramuscular
INR	International Normalized Ratio
ITP	idiopathic thrombocytopenic purpura
IUD	intrauterine device
IUFD	intrauterine fetal demise or death
IUGR	intrauterine growth restricted
IUI	intrauterine insemination
IUP	intrauterine pregnancy
IUPC	intrauterine pressure catheter
IUT	intrauterine transfusion
IVC	inferior vena cava
IVF	in vitro fertilization
IVP	intravenous pyelogram
KB	Kleihauer-Betke test
KOH	potassium hydroxide
KUB	kidneys/ureter/bladder (x-ray)
LBW	low birth weight
LCHAD	long-chain hydroxyacyl-CoA dehydrogenase
LCIS	lobular carcinoma in situ
LDH	lactate dehydrogenase
LDL	low-density lipoprotein
LEEP	loop electrosurgical excision procedure
LFT	liver function test
LGA	large for gestational age
LGV	lymphogranuloma venereum
LH	luteinizing hormone
LIQ	lower inner quadrant
Lletz	large loop excision of the transformation zone
LMP	last menstrual period
LOQ	lower outer quadrant
LOT	left occiput transverse
LSIL	low-grade squamous intraepithelial lesion
LTL	laparoscopic tubal ligation
MAO	monoamine oxidase
MESA	microsurgical epididymal sperm aspiration
MHATP	microhemagglutination assay for antibodies to *T. pallidum*
MI	myocardial infarction
MIF	müllerian inhibiting factor
MLK	myosin light-chain kinase
MRI	magnetic resonance imaging
MRKH	Mayer-Rokitansky-Küster-Hauser (syndrome)
MSAFP	maternal serum α-fetoprotein
MTHFR	methyl tetrahydrofolate reductase
NPO	nil per os (nothing by mouth)
NPV	negative predictive value
NRFT	nonreassuring fetal testing
NSAID	nonsteroidal anti-inflammatory drug
NST	nonstress test
NSVD	normal spontaneous vaginal delivery
NT	nuchal translucency
NTD	neural tube defect
OA	occiput anterior
OCP	oral contraceptive pill
OCT	oxytocin challenge test
OI	ovulation induction
OP	occiput posterior
OT	occiput transverse
OTC	over-the-counter
P	parity
PCOS	polycystic ovarian syndrome
PCR	polymerase chain reaction
PDA	patent ductus arteriosus
PE	pulmonary embolus
PFTs	pulmonary function tests
PID	pelvic inflammatory disease
PIH	pregnancy-induced hypertension
PMDD	premenstrual dysphoric disorder
PMN	polymorphonuclear leukocyte
PMOF	premature ovarian failure
PMS	premenstrual syndrome
PO	per os (by mouth)
POCs	products of conception
POP	progesterone-only contraceptive pills
POP-Q	pelvic organ prolapse quantification system
PPCM	peripartum cardiomyopathy
PPD	purified protein derivative
PPROM	preterm premature rupture of membranes
PPS	postpartum sterilization
PPV	positive predictive value
PROM	premature rupture of membranes
PSTT	placental site trophoblastic tumor
PT	prothrombin time

PTL	preterm labor
PTT	partial thromboplastin time
PTU	propylthiouracil
PUBS	percutaneous umbilical blood sampling
QD	each day
QID	four times a day
RBC	red blood cell
RDS	respiratory distress syndrome
ROM	rupture of membranes
ROT	right occiput transverse
RPR	rapid plasma reagin
RR	respiratory rate
SAB	spontaneous abortion
SCC	squamous cell carcinoma
SERM	selective estrogen receptor modulator
SGA	small for gestational age
SHBG	sex hormone binding globulin
SIDS	sudden infant death syndrome
SLE	systemic lupus erythematosus
SNRIs	serotonin and norepinephrine reuptake inhibitors
SPT	septic pelvic thrombophlebitis
SROM	spontaneous rupture of membranes
SSRIs	selective serotonin reuptake inhibitors
STD	sexually transmitted disease
STI	sexually transmitted infection
SVT	superficial vein thrombophlebitis
TAB	therapeutic abortion
TAC	transabdominal cerclage
TAHBSO	total abdominal hysterectomy and bilateral salpingo-oophorectomy
TBG	thyroid binding globulin
TENS	transcutaneous electrical nerve stimulation
TFTs	thyroid function tests
TLC	total lung capacity
TNM	tumor/node/metastasis
TOA	tubo-ovarian abscess
TOLAC	trial of labor after cesarean
TOV	transposition of the vessels
TPAL	term, preterm, aborted, living
TRH	thyrotropin-releasing hormone
TSE	testicular sperm extraction
TSH	thyroid-stimulating hormone
TSI	thyroid-stimulating immunoglobulins
TSS	toxic shock syndrome
TSST	toxic shock syndrome toxin
TTTS	twin-to-twin transfusion syndrome
UA	urinalysis
UAE	uterine artery embolization
UG	urogenital
UIQ	upper inner quadrant
UOQ	upper outer quadrant
UPI	uteroplacental insufficiency
US	ultrasound
UTI	urinary tract infection
V/Q	ventilation/perfusion ratio
VAIN	vaginal intraepithelial neoplasia
VBAC	vaginal birth after cesarean
V_D	volume of distribution
VDRL	Venereal Disease Research Laboratory
VIN	vulvar intraepithelial neoplasia
VSD	ventricular septal defect
VZIG	varicella zoster immune globulin
VZV	varicella zoster virus
WBC	white blood cell
XR	x-ray

Contents

Chapter 1

Pregnancy and Prenatal Care

PREGNANCY

Pregnancy is the state of having products of conception implanted normally or abnormally in the uterus or occasionally elsewhere. It is terminated by spontaneous or elective abortion or by delivery. A myriad of physiologic changes occur in a pregnant woman, which affect every organ system.

DIAGNOSIS

In a patient who has regular menstrual cycles and is sexually active, a period delayed by more than a few days to a week is suggestive of pregnancy. Even at this early stage, patients may exhibit signs and symptoms of pregnancy. On physical examination, a variety of findings indicate pregnancy (Table 1-1).

Many over-the-counter (OTC) urine pregnancy tests have a high sensitivity and will be positive around the time of the missed menstrual cycle. These urine tests and the hospital laboratory serum assays test for the beta subunit of human chorionic gonadotropin (β-hCG). This hormone produced by the placenta will rise to a peak of 100,000 mIU/mL by 10 weeks of gestation, decrease throughout the second trimester, and then level off at approximately 20,000 to 30,000 mIU/mL in the third trimester.

A viable pregnancy can be confirmed by ultrasound, which may show the gestational sac as early as 5 weeks on a transvaginal ultrasound or at a β-hCG of 1,500 to 2,000 mIU/mL. Fetal heart motion may be seen on transvaginal ultrasound as soon as 6 weeks or at a β-hCG of 5,000 to 6,000 mIU/mL.

TERMS AND DEFINITIONS

From the time of fertilization until the pregnancy is 8 weeks along (10 weeks' gestational age [GA]), the conceptus is called an **embryo**. After 8 weeks until the time of birth, it is designated a **fetus**. The term **infant** is used for the period between delivery and 1 year of age. Pregnancy is divided into trimesters. The **first trimester** lasts until 12 weeks but is also defined as up to 14 weeks' GA, the **second trimester** lasts from 12 to 14 until 24 to 28 weeks' GA, and the **third trimester** lasts from 24 to 28 weeks until delivery. An infant delivered prior to 24 weeks is considered to be **previable**, delivered between 24 and 37 weeks is considered **preterm**, and between 37 and 42 weeks is considered **term**. A pregnancy carried beyond 42 weeks is considered **postterm**.

Gravidity (G) refers to the number of times a woman has been pregnant, and **parity** (P) refers to the number of pregnancies that led to a birth at or beyond 20 weeks' GA or of an infant weighing more than 500 g. For example, a woman who has given birth to one set of twins would be a G1 P1, as a multiple gestation is considered as just one pregnancy. A more specific designation of pregnancy outcomes divides parity into **term** and **preterm** deliveries and also adds the number of **abortuses** and the number of **living** children. This is known as the TPAL designation. Abortuses include all pregnancy losses prior to 20 weeks, both therapeutic and spontaneous, as well as ectopic pregnancies. For example, a woman who has given birth to one set of preterm twins, one term infant, and had two miscarriages would be a G4 P1-1-2-3.

The prefixes nulli-, primi-, and multi- are used with respect to gravidity and parity to refer to having 0, 1, or more than 1, respectively. For example, a woman who has been pregnant twice, one ectopic pregnancy and one full-term birth, would be multigravid and primiparous. Unfortunately, this terminology often gets misused with individuals referring to women with a first pregnancy as primiparous, rather than nulliparous. Obstetricians also use the term **grand multip**, which refers to a woman whose parity is greater than or equal to 5.

Dating of Pregnancy

The GA of a fetus is the age in weeks and days measured from the last menstrual period (LMP). **Developmental age** (DA) or conceptional age or embryonic age is the number of weeks and days since fertilization. Because fertilization usually occurs about 14 days after the first day of the prior menstrual period, the GA is usually 2 weeks more than the DA.

Classically, the **Nagele rule** for calculating the **estimated date of confinement** (EDC), or estimated date of delivery (EDD), is to subtract 3 months from the LMP and add 7 days. Thus, a pregnancy with an LMP of January 16, 2012 would have an EDC of 10/23/12. Exact dating uses an EDC calculated as 280 days after a certain LMP. If the date of ovulation is known, as in assisted reproductive technology (ART), the EDC can be calculated by adding 266 days. Pregnancy dating can be confirmed and should be consistent with the examination of the uterine size at the first prenatal appointment.

TABLE 1-1 Signs and Symptoms of Pregnancy

Signs
Bluish discoloration of vagina and cervix (Chadwick sign)
Softening and cyanosis of the cervix at or after 4 wk (Goodell sign)
Softening of the uterus after 6 wk (Ladin sign)
Breast swelling and tenderness
Development of the linea nigra from umbilicus to pubis
Telangiectasias
Palmar erythema
Symptoms
Amenorrhea
Nausea and vomiting
Breast pain
Quickening—fetal movement

With an uncertain LMP, ultrasound is often used to determine the EDC. Ultrasound has a level of uncertainty that increases during the pregnancy, but it is rarely off by more than 7% to 8% at any GA. A safe rule of thumb is that the ultrasound should not differ from LMP dating by more than 1 week in the first trimester, 2 weeks in the second trimester, and 3 weeks in the third trimester. The dating done with crown–rump length in the first half of the first trimester is probably even more accurate, to within 3 to 5 days.

Other measures used to estimate GA include pregnancy landmarks such as auscultation of the fetal heart (FH) at 20 weeks by nonelectronic fetoscopy or at 10 weeks by Doppler ultrasound, as well as maternal awareness of fetal movement or "quickening," which occurs between 16 and 20 weeks.

Because ultrasound dating of pregnancy decreases in accuracy as the pregnancy progresses, determining and confirming pregnancy dating at the first interaction between a pregnant woman and the health care system is imperative. A woman who presents to the emergency department may not return for prenatal care, so dating should be confirmed at that visit. Pregnancy dating is particularly important because a number of decisions regarding care are based on accurate dating. One such decision is whether to resuscitate a newborn at the threshold of viability, which may be at 23 or 24 weeks of gestation depending on the institution. Another is the induction of labor at 41 weeks of gestation. Approximately 5% to 15% of women may be oligo-ovulatory, meaning they ovulate beyond the usual 14th day of the cycle. Thus, their LMP dating may overdiagnose a prolonged (≥41 weeks' gestation) or postterm pregnancy (≥42 weeks' gestation). Thus, early verification or correction of dating can correct such misdating.

PHYSIOLOGY OF PREGNANCY

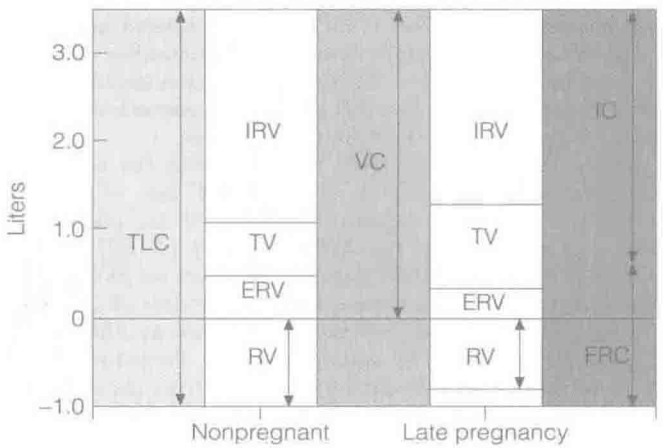
Cardiovascular

During pregnancy, **cardiac output** increases by 30% to 50%. Most increases occur during the first trimester, with the maximum being reached between 20 and 24 weeks' gestation and maintained until delivery. The increase in cardiac output is first due to an increase in stroke volume and is then maintained by an increase in heart rate as the stroke volume decreases to near prepregnancy levels by the end of the third trimester. **Systemic vascular resistance** decreases during pregnancy, resulting in a fall in arterial blood pressure. This decrease is most likely due to elevated progesterone, leading to smooth muscle relaxation. There is a decrease in systolic blood pressure of 5 to 10 mm Hg and in diastolic blood pressure of 10 to 15 mm Hg that nadirs at week 24. Between 24 weeks' gestation and term, the blood pressure slowly returns to prepregnancy levels but should never exceed them.

Pulmonary

There is an increase of 30% to 40% in tidal volume (V_T) during pregnancy (Fig. 1-1) despite the fact that the total lung capacity (TLC) is decreased by 5% due to the elevation of the diaphragm. This increase in V_T decreases the expiratory reserve volume by about 20%. The increase in V_T with a constant respiratory rate leads to an increase in minute ventilation of 30% to 40%, which in turn leads to an increase in alveolar (PAO_2) and arterial (PaO_2) PO_2 levels and a decrease in $PACO_2$ and $PaCO_2$ levels.

$PaCO_2$ decreases to approximately 30 mm Hg by 20 weeks' gestation from 40 mm Hg during prepregnancy. This change leads to an increased CO_2 gradient between mother and fetus and is likely caused by elevated progesterone levels that either increase the respiratory system's responsiveness to CO_2 or act as a primary stimulant. This gradient facilitates oxygen delivery to the fetus and carbon dioxide removal from the fetus. Dyspnea of pregnancy occurs in 60% to 70% of patients. This is possibly secondary to decreased $PaCO_2$ levels, increased V_T, or decreased TLC.



TLC–total lung capacity
VC–vital capacity
IC–inspiratory capacity
FRC–functional residual capacity
IRV–inspiratory reserve volume
TV–tidal volume
ERV–expiratory reserve volume
RV–residual volume

Figure 1-1 • Lung volumes in nonpregnant and pregnant women.

Gastrointestinal

Nausea and vomiting occur in more than 70% of pregnancies. This has been termed **morning sickness** even though it can occur anytime throughout the day. These symptoms have been attributed to the elevation in estrogen, progesterone, and hCG. They may also be due to hypoglycemia and can be treated with frequent snacking. The nausea and vomiting typically resolve by 14 to 16 weeks' gestation. **Hyperemesis gravidarum** refers to a severe form of morning sickness associated with weight loss (≥5% of prepregnancy weight) and ketosis.

During pregnancy, the stomach has prolonged gastric emptying times and the gastroesophageal sphincter has decreased tone. Together, these changes lead to reflux and possibly combine with decreased esophageal tone to cause ptyalism, or spitting, during pregnancy. The large bowel also has decreased motility, which leads to increased water absorption and constipation.

Renal

The kidneys increase in size and the ureters dilate during pregnancy, which may lead to increased rates of pyelonephritis. The glomerular filtration rate (GFR) increases by 50% early in pregnancy and is maintained until delivery. As a result of increased GFR, blood urea nitrogen and creatinine decrease by about 25%. An increase in the renin–angiotensin system leads to increased levels of aldosterone, which results in increased sodium resorption. However, plasma levels of sodium do not increase because of the simultaneous increase in GFR.

Hematology

Although the plasma volume increases by 50% in pregnancy, the RBC volume increases by only 20% to 30%, which leads to a decrease in the hematocrit, or dilutional anemia. The WBC count increases during pregnancy to a mean of 10.5 million/mL with a range of 6 to 16 million. During labor, stress may cause the WBC count to rise to over 20 million/mL. There is a slight decrease in the concentration of platelets, probably secondary to increased plasma volume and an increase in peripheral destruction. Although in 7% to 8% of patients the platelet count may be between 100 and 150 million/mL, a drop in the platelet count below 100 million/mL over a short time is not normal and should be investigated promptly.

Pregnancy is considered to be a hypercoagulable state with an increase in the number of thromboembolic events. There are elevations in the levels of fibrinogen and factors VII–X. However, the actual clotting and bleeding times do not change. The increased rate of thromboembolic events in pregnancy may also be secondary to the other elements of Virchow triad, that is an increase in venous stasis and vessel endothelial damage.

Endocrine

Pregnancy is a hyperestrogenic state. The increased estrogen is produced primarily by the placenta, with the ovaries contributing to a lesser degree. Unlike estrogen production in the ovaries, where estrogen precursors are produced in ovarian theca cells and transferred to the ovarian granulosa cells, estrogen in the placenta is derived from circulating plasma-borne precursors produced by the maternal adrenal glands. Fetal well-being has been correlated with maternal serum estrogen levels, with low estrogen levels being associated with conditions such as fetal death and anencephaly.

The hormone hCG is composed of two dissimilar alpha and beta subunits. The alpha subunit of hCG is identical to the alpha subunits of luteinizing hormone (LH), follicle-stimulating hormone (FSH), and thyroid-stimulating hormone (TSH), whereas the beta subunits differ. Levels of hCG double approximately every 48 hours during early pregnancy, reaching a peak at approximately 10 to 12 weeks, and thereafter declining to reach a steady state after week 15.

The placenta produces hCG, which acts to maintain the corpus luteum in early pregnancy. The corpus luteum produces progesterone, which maintains the endometrium. Eventually, the placenta takes over progesterone production and the corpus luteum degrades into the corpus albicans. Progesterone levels increase over the course of pregnancy. Progesterone causes relaxation of smooth muscle, which has multiple effects on the gastrointestinal, cardiovascular, and genitourinary systems. **Human placental lactogen** (hPL) is produced in the placenta and is important for ensuring a constant nutrient supply to the fetus. hPL, also known as human chorionic somatomammotropin (hCS), induces lipolysis with a concomitant increase in circulating free fatty acids. hPL also acts as an insulin antagonist, along with various other placental hormones, thereby having a diabetogenic effect. This leads to increased levels of insulin and protein synthesis. Levels of **prolactin** are markedly increased during pregnancy. These levels decrease after delivery but later increase in response to suckling.

There are two major changes in thyroid hormones during pregnancy. First, estrogen stimulates thyroid binding globulin (TBG), leading to an elevation in total T3 and T4, but free T3 and T4 remain relatively constant. Second, hCG has a weak stimulating effect on the thyroid, likely because its alpha subgroup is similar to TSH. This leads to a slight increase in T3 and T4 and a slight decrease in TSH early in pregnancy. Overall, however, pregnancy is considered a euthyroid state.

Musculoskeletal and Dermatologic

The obvious change in the center of gravity during pregnancy can lead to a shift in posture and lower back strain, which worsens throughout pregnancy, particularly during the third trimester. Numerous changes occur in the skin, including spider angiomata and palmar erythema secondary to increased estrogen levels and hyperpigmentation of the nipples, umbilicus, abdominal midline (the **linea nigra**), perineum, and face (**melasma** or **chloasma**) secondary to increased levels of the melanocyte-stimulating hormones and the steroid hormones. Pregnancy is also associated with carpal tunnel syndrome, which results from compression of the median nerve. The incidence in pregnancy varies greatly and symptoms are usually self-limited.

Nutrition

Nutritional requirements increase during pregnancy and breastfeeding. An average woman requires 2,000 to 2,500 kcal/day. The caloric requirement is increased by 300 kcal/day during pregnancy and by 500 kcal/day when breastfeeding. Thus, pregnancy is not the caloric equivalent of eating for two; more accurately, it is approximately eating for 1.15. Most patients should gain between 20 and 30 lb during pregnancy. Overweight women are advised to gain less, between 15 and 25 lb; underweight women are advised to gain more, 28 to 40 lb. Unfortunately, a large proportion of women gain more than the recommended amount, which contributes to a number of complications in pregnancy plus postpartum weight retention and downstream obesity. It is the responsibility of each prenatal care provider to review diet and exercise during pregnancy.

In addition to the increased caloric requirements, there are increased nutritional requirements for protein, iron, folate, calcium, and other vitamins and minerals. The protein requirement increases from 60 to 70 or 75 g/day. Recommended calcium intake is 1.5 g/day. Many patients develop iron deficiency anemia because of the increased demand on hematopoiesis both by the mother and the fetus. Folate requirements increase from 0.4 to 0.8 mg/day and are important in preventing neural tube defects.

All patients are advised to take prenatal vitamins during pregnancy. These are designed to compensate for the increased nutritional demands of pregnancy. Furthermore, any patient whose hematocrit falls during pregnancy is advised to increase iron intake with oral supplementation (Table 1-2).

PRENATAL CARE

Prenatal visits are designed to screen for various complications of pregnancy and to educate the patient. They include a series of outpatient office visits that involve routine physical examinations and various screening tests that occur at different points in the prenatal care. Important issues of prenatal care include initial patient evaluation, routine patient evaluation, nutrition, disease states during the pregnancy, and preparing for the delivery.

INITIAL VISIT

This is often the longest of the prenatal visits because it involves obtaining a complete history and performing a physical examination as well as a battery of initial laboratory tests. It should occur early in the first trimester, between 6 and 10 weeks, although occasionally patients will not present for their initial prenatal visit until later in their pregnancy. At this visit, diet, exercise, and weight gain goals should also be discussed.

History

The patient's history includes the present pregnancy, the LMP, and symptoms during the pregnancy. After this, an obstetric history of prior pregnancies, including date, outcome (e.g., SAB [spontaneous abortion], TAB [therapeutic abortion], ectopic pregnancy, term delivery), mode of delivery, length of time in labor and second stage, birth weight, and any complications, should be obtained. Finally, a complete medical, surgical, family, and social history should be obtained.

Physical Examination

A complete physical examination is performed, paying particular attention to the patient's prior medical and surgical history. The pelvic examination includes a Pap smear, unless one has been done in the past 6 months, and cultures for gonorrhea and

TABLE 1-2 Recommended Daily Dietary Allowances for Nonpregnant, Pregnant, and Lactating Women

	Nonpregnant Women by Age					Pregnant Women	Lactating Women
	11–14 y	15–18 y	19–22 y	23–50 y	51+ y		
Energy (kcal)	2,400	2,100	2,100	2,000	1,800	+300	+500
Protein (g)	44	48	46	46	46	+30	+20
Fat-soluble vitamins	800	800	800	800	800	1,000	1,200
Vitamin A activity (RE) (IU)	4,000	4,000	4,000	4,000	4,000	5,000	6,000
Vitamin D (IU)	400	400	400	—	—	400	400
Vitamin E activity (IU)	12	12	12	12	12	15	15
Water-soluble vitamins							
Ascorbic acid (mg)	45	45	45	45	45	60	80
Folacin (mg)	400	400	400	400	400	800	600
Niacin (mg)	16	14	14	13	12	+2	+4
Riboflavin (mg)	1.3	1.4	1.4	1.2	1.1	+0.3	+0.5
Thiamin (mg)	1.2	1.1	1.1	1	1	+0.3	+0.3
Vitamin B_6 (mg)	1.6	2	2	2	2	2.5	2.5
Vitamin B_{12} (mg)	3	3	3	3	3	4	4
Minerals							
Calcium (mg)	1,200	1,200	800	800	800	1,200	1,200
Iodine (mg)	115	115	100	100	80	125	150
Iron (mg)	18	18	18	18	10	+18	18
Magnesium (mg)	300	300	300	300	300	450	450
Phosphorus (mg)	1,200	1,200	800	800	800	1,200	1,200
Zinc (mg)	15	15	15	15	15	20	25

IU, International Unit. From Gabbe SG, Niebyl JR, Simpsen JL. *Obstetrics: Normal and Problem Pregnancies*, 4th ed. New York, NY: Churchill Livingstone; 2002:196.