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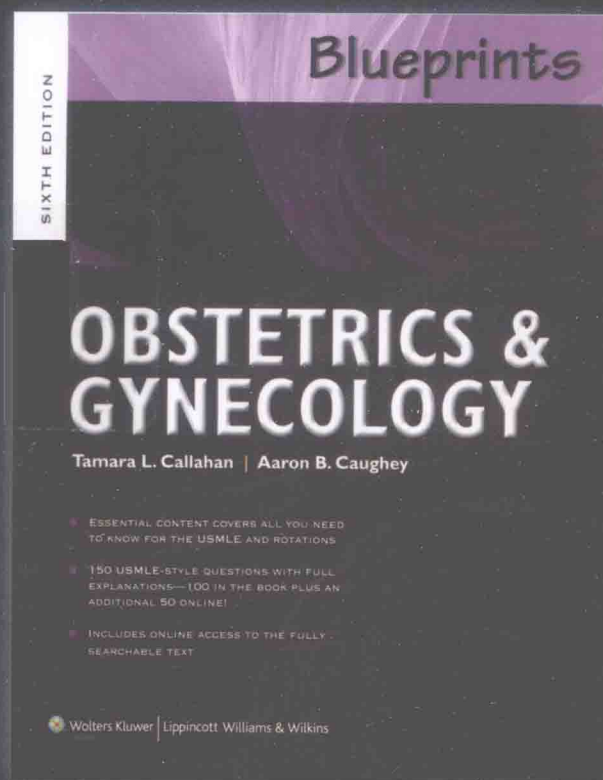
OBSTETRICS & GYNECOLOGY

(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

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

Abbreviations

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

Abbreviations

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

Contents

<i>Preface</i>	<i>x</i>
<i>Acknowledgments</i>	<i>xi</i>
<i>Abbreviations</i>	<i>xii</i>
PART I: Obstetrics	1
1 Pregnancy and Prenatal Care	1
2 Early Pregnancy Complications	13
3 Prenatal Screening, Diagnosis, and Treatment	25
4 Normal Labor and Delivery	40
5 Antepartum Hemorrhage	62
6 Complications of Labor and Delivery	78
7 Fetal Complications of Pregnancy	94
8 Hypertension and Pregnancy	111
9 Diabetes During Pregnancy	121
10 Infectious Diseases in Pregnancy	131
11 Other Medical Complications of Pregnancy	147
12 Postpartum Care and Complications	161
PART II: Gynecology	174
13 Benign Disorders of the Lower Genital Tract	174
14 Benign Disorders of the Upper Genital Tract	187
15 Endometriosis and Adenomyosis	204
16 Infections of the Lower Female Reproductive Tract	215
17 Upper Female Reproductive Tract and Systemic Infections	230
18 Pelvic Organ Prolapse	239
19 Urinary Incontinence	250
20 Puberty, the Menstrual Cycle, and Menopause	267
21 Amenorrhea	281
22 Abnormalities of the Menstrual Cycle	293
23 Hirsutism and Virilism	306
24 Contraception and Sterilization	316

25	Elective Termination of Pregnancy.....	337
26	Infertility and Assisted Reproductive Technologies	346
27	Neoplastic Disease of the Vulva and Vagina.....	360
28	Cervical Neoplasia and Cervical Cancer.....	369
29	Endometrial Cancer	383
30	Ovarian and Fallopian Tube Tumors	392
31	Gestational Trophoblastic Disease.....	404
32	Benign Breast Disease and Breast Cancer.....	416
	<i>Questions</i>	<i>434</i>
	<i>Answers</i>	<i>450</i>
	<i>Index.....</i>	<i>466</i>

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 **preivable**, 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

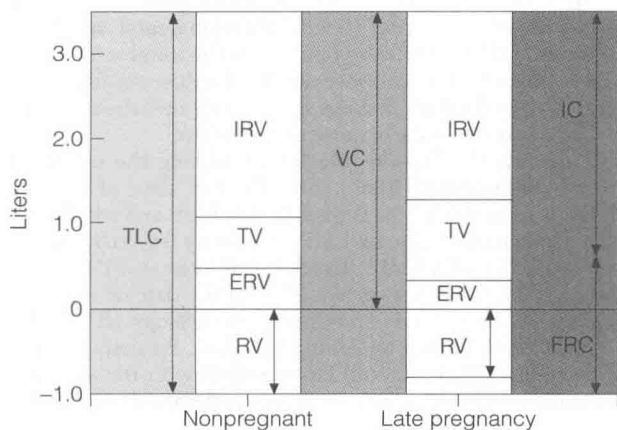
Cardiovascular

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 ($\geq 5\%$ 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 ptialism, 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 angiomas 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.