

Detailed Contents

Chapter 1		Chapter 2	
Elements of the Immune System and their Roles in Defense		Innate Immunity: the Immediate Response to Infection	
	1		29
1-1	Numerous commensal microorganisms inhabit healthy human bodies	2-1	Physical barriers colonized by commensal microorganisms protect against infection by pathogens
	2		29
1-2	Pathogens are infectious organisms that cause disease	2-2	Intracellular and extracellular pathogens require different types of immune response
	3		30
1-3	The skin and mucosal surfaces form barriers against infection	2-3	Complement is a system of plasma proteins that mark pathogens for destruction
	4		31
1-4	The innate immune response causes inflammation at sites of infection	2-4	At the start of an infection, complement activation proceeds by the alternative pathway
	8		32
1-5	The adaptive immune response adds to an ongoing innate immune response	2-5	Regulatory proteins determine the extent and site of C3b deposition
	10		34
1-6	Adaptive immunity is better understood than innate immunity	2-6	Phagocytosis by macrophages provides a first line of cellular defense against invading microorganisms
	12		36
1-7	Immune system cells with different functions all derive from hematopoietic stem cells	2-7	The terminal complement proteins lyse pathogens by forming membrane pores
	12		37
1-8	Immunoglobulins and T-cell receptors are the diverse lymphocyte receptors of adaptive immunity	2-8	Small peptides released during complement activation induce local inflammation
	16		39
1-9	On encountering their specific antigen, B cells and T cells differentiate into effector cells	2-9	Several classes of plasma protein limit the spread of infection
	17		39
1-10	Antibodies bind to pathogens and cause their inactivation or destruction	2-10	Antimicrobial peptides kill pathogens by perturbing their membranes
	18		41
1-11	Most lymphocytes are present in specialized lymphoid tissues	2-11	Pentraxins are plasma proteins of innate immunity that bind microorganisms and target them to phagocytes
	19		43
1-12	Adaptive immunity is initiated in secondary lymphoid tissues		
	20		
1-13	The spleen provides adaptive immunity to blood infections		
	23		
1-14	Most secondary lymphoid tissue is associated with the gut		
	25		
Summary to Chapter 1	26	Summary to Chapter 2	43
Questions	27	Questions	44

Chapter 3

Innate Immunity: the Induced Response to Infection

3-1	Cellular receptors of innate immunity distinguish 'non-self' from 'self'	47
3-2	Tissue macrophages carry a battery of phagocytic and signaling receptors	49
3-3	Recognition of LPS by TLR4 induces changes in macrophage gene expression	51
3-4	Activation of resident macrophages induces a state of inflammation at sites of infection	53
3-5	NOD-like receptors recognize bacterial degradation products in the cytoplasm	54
3-6	Inflammasomes amplify the innate immune response by increasing the production of IL-1 β	55
3-7	Neutrophils are dedicated phagocytes and the first effector cells recruited to sites of infection	56
3-8	Inflammatory cytokines recruit neutrophils from the blood to the infected tissue	57
3-9	Neutrophils are potent killers of pathogens and are themselves programmed to die	59
3-10	Inflammatory cytokines raise body temperature and activate the liver to make the acute-phase response	62
3-11	The lectin pathway of complement activation is initiated by the mannose-binding lectin	63
3-12	C-reactive protein triggers the classical pathway of complement activation	66
3-13	Toll-like receptors sense the presence of the four main groups of pathogenic microorganisms	66
3-14	Genetic variation in Toll-like receptors is associated with resistance and susceptibility to disease	67
3-15	Internal detection of viral infection induces cells to make an interferon response	68
3-16	Plasmacytoid dendritic cells are factories for making large quantities of type I interferons	71
3-17	Natural killer cells are the main circulating lymphocytes that contribute to the innate immune response	71
3-18	Two subpopulations of NK cells are differentially distributed in blood and tissues	72
3-19	NK-cell cytotoxicity is activated at sites of virus infection	73
3-20	NK cells and macrophages activate each other at sites of infection	75

3-21	Interactions between dendritic cells and NK cells influence the immune response	76
	Summary to Chapter 3	78
	Questions	78

Chapter 4

	Antibody Structure and the Generation of B-Cell Diversity	81
	The structural basis of antibody diversity	82
4-1	Antibodies are composed of polypeptides with variable and constant regions	82
4-2	Immunoglobulin chains are folded into compact and stable protein domains	83
4-3	An antigen-binding site is formed from the hypervariable regions of a heavy-chain V domain and a light-chain V domain	85
4-4	Antigen-binding sites vary in shape and physical properties	86
4-5	Monoclonal antibodies are produced from a clone of antibody-producing cells	88
4-6	Monoclonal antibodies are used as treatments for a variety of diseases	90
	Summary	91
	Generation of immunoglobulin diversity in B cells before encounter with antigen	91
4-8	Random recombination of gene segments produces diversity in the antigen-binding sites of immunoglobulins	92
4-9	Recombination enzymes produce additional diversity in the antigen-binding site	95
4-10	Developing and naive B cells use alternative mRNA splicing to make both IgM and IgD	96
4-11	Each B cell produces immunoglobulin of a single antigen specificity	96
4-12	Immunoglobulin is first made in a membrane-bound form that is present on the B-cell surface	97
	Summary	98
	Diversification of antibodies after B cells encounter antigen	98
4-13	Secreted antibodies are produced by an alternative pattern of heavy-chain RNA processing	98
4-14	Rearranged V-region sequences are further diversified by somatic hypermutation	100
4-15	Isotype switching produces immunoglobulins with different C regions but identical antigen specificities	101
4-16	Antibodies with different C regions have different effector functions	103

4-17	The four subclasses of IgG have different and complementary functions	105	The major histocompatibility complex	135	
	Summary	107	5-18	The diversity of MHC molecules in the human population is due to multigene families and genetic polymorphism	135
	Summary to Chapter 4	107	5-19	The HLA class I and class II genes occupy different regions of the HLA complex	137
	Questions	110	5-20	Other proteins involved in antigen processing and presentation are encoded in the HLA class II region	138
Chapter 5			5-21	MHC polymorphism affects the binding of peptide antigens and their presentation to T cells	138
	Antigen Recognition by T Lymphocytes	113	5-22	MHC diversity results from selection by infectious disease	140
	T-cell receptor diversity	114	5-23	MHC polymorphism triggers T-cell reactions that can reject transplanted organs	143
5-1	The T-cell receptor resembles a membrane-associated Fab fragment of immunoglobulin	114		Summary	144
5-2	T-cell receptor diversity is generated by gene rearrangement	115		Summary to Chapter 5	144
5-3	The RAG genes were key elements in the origin of adaptive immunity	117		Questions	145
5-4	Expression of the T-cell receptor on the cell surface requires association with additional proteins	117	Chapter 6		
5-5	A distinct population of T cells expresses a second class of T-cell receptor with γ and δ chains	118		The Development of B Lymphocytes	149
	Summary	119		The development of B cells in the bone marrow	150
	Antigen processing and presentation	120	6-1	B-cell development in the bone marrow proceeds through several stages	150
5-6	T-cell receptors recognize peptide antigens bound to MHC molecules	121	6-2	B-cell development is stimulated by bone marrow stromal cells	151
5-7	Two classes of MHC molecule present peptide antigens to two types of T cell	122	6-3	Pro-B-cell rearrangement of the heavy-chain locus is an inefficient process	152
5-8	The two classes of MHC molecule have similar three-dimensional structures	123	6-4	The pre-B-cell receptor monitors the quality of immunoglobulin heavy chains	153
5-9	MHC molecules bind a variety of peptides	124	6-5	The pre-B-cell receptor causes allelic exclusion at the immunoglobulin heavy-chain locus	154
5-10	MHC class I and MHC class II molecules function in different intracellular compartments	125	6-6	Rearrangement of the light-chain loci by pre-B cells is relatively efficient	155
5-11	Peptides generated in the cytosol are transported to the endoplasmic reticulum for binding to MHC class I molecules	126	6-7	Developing B cells pass two checkpoints in the bone marrow	157
5-12	MHC class I molecules bind peptides as part of a peptide-loading complex	127	6-8	A program of protein expression underlies the stages of B-cell development	157
5-13	Peptides presented by MHC class II molecules are generated in acidified intracellular vesicles	129	6-9	Many B-cell tumors carry chromosomal translocations that join immunoglobulin genes to genes that regulate cell growth	160
5-14	Invariant chain prevents MHC class II molecules from binding peptides in the endoplasmic reticulum	130	6-10	B cells expressing the glycoprotein CD5 express a distinctive repertoire of receptors	161
5-15	Cross-presentation enables extracellular antigens to be presented by MHC class I	131		Summary	162
5-16	MHC class I molecules are expressed by most cell types, MHC class II molecules are expressed by few cell types	132		Selection and further development of the B-cell repertoire	163
5-17	The T-cell receptor specifically recognizes both peptide and MHC molecule	132	6-11	The population of immature B cells is purged of cells bearing self-reactive B-cell receptors	164
	Summary	133			

6-12	The antigen receptors of autoreactive immature B cells can be modified by receptor editing	165	7-14	T cells undergo further differentiation in secondary lymphoid tissues after encounter with antigen	193
6-13	Immature B cells specific for monovalent self antigens are made nonresponsive to antigen	166		Summary	194
6-14	Maturation and survival of B cells requires access to lymphoid follicles	167		Summary to Chapter 7	194
6-15	Encounter with antigen leads to the differentiation of activated B cells into plasma cells and memory B cells	168		Questions	196
6-16	Different types of B-cell tumor reflect B cells at different stages of development	170		Chapter 8	
	Summary	170		T Cell-Mediated Immunity	199
	Summary to Chapter 6	172		Activation of naive T cells by antigen	199
	Questions	173	8-1	Dendritic cells carry antigens from sites of infection to secondary lymphoid tissues	200
	Chapter 7		8-2	Dendritic cells are adept and versatile at processing pathogen antigens	202
	The Development of T Lymphocytes	177	8-3	Naive T cells first encounter antigen presented by dendritic cells in secondary lymphoid tissues	203
7-1	T cells develop in the thymus	178	8-4	Homing of naive T cells to secondary lymphoid tissues is determined by chemokines and cell-adhesion molecules	204
7-2	Thymocytes commit to the T-cell lineage before rearranging their T-cell receptor genes	180	8-5	Activation of naive T cells requires signals from the antigen receptor and a co-stimulatory receptor	206
7-3	The two lineages of T cells arise from a common thymocyte progenitor	181	8-6	Signals from T-cell receptors, co-receptors, and co-stimulatory receptors activate naive T cells	207
7-4	Gene rearrangement in double-negative thymocytes leads to assembly of either a $\gamma:\delta$ receptor or a pre-T-cell receptor	183	8-7	Proliferation and differentiation of activated naive T cells are driven by the cytokine interleukin-2	209
7-5	Thymocytes can make four attempts to rearrange a β -chain gene	184	8-8	Antigen recognition in the absence of co-stimulation leads to a state of T-cell anergy	210
7-6	Rearrangement of the α -chain gene occurs only in pre-T cells	185	8-9	Activation of naive CD4 T cells gives rise to effector CD4 T cells with distinctive helper functions	211
7-7	Stages in T-cell development are marked by changes in gene expression	186	8-10	The cytokine environment determines which differentiation pathway a naive T cell takes	213
	Summary	188	8-11	Positive feedback in the cytokine environment can polarize the effector CD4 T-cell response	214
	Positive and negative selection of the T-cell repertoire	188	8-12	Naive CD8 T cells require stronger activation than naive CD4 T cells	215
7-8	T cells that recognize self-MHC molecules are positively selected in the thymus	189		Summary	217
7-9	Continuing α -chain gene rearrangement increases the chance for positive selection	190		The properties and functions of effector T cells	218
7-10	Positive selection determines expression of either the CD4 or the CD8 co-receptor	191	8-13	Cytotoxic CD8 T cells and effector CD4 T_H1 , T_H2 , and T_H17 work at sites of infection	218
7-11	T cells specific for self antigens are removed in the thymus by negative selection	192	8-14	Effector T-cell functions are mediated by cytokines and cytotoxins	220
7-12	Tissue-specific proteins are expressed in the thymus and participate in negative selection	192	8-15	Cytokines change the patterns of gene expression in the cells targeted by effector T cells	221
7-13	Regulatory CD4 T cells comprise a distinct lineage of CD4 T cells	193			

8-16	Cytotoxic CD8 T cells are selective and serial killers of target cells at sites of infection	222	9-12	Dimeric IgA protects the mucosal surfaces of the body	246
8-17	Cytotoxic T cells kill their target cells by inducing apoptosis	223	9-13	IgE provides a mechanism for the rapid ejection of parasites and other pathogens from the body	247
8-18	Effector T _H 1 CD4 cells induce macrophage activation	224	9-14	Mothers provide protective antibodies to their young, both before and after birth	250
8-19	T _{FH} cells, and the naive B cells that they help, recognize different epitopes of the same antigen	225	9-15	High-affinity neutralizing antibodies prevent viruses and bacteria from infecting cells	251
8-20	Regulatory CD4 T cells limit the activities of effector CD4 and CD8 T cells	226	9-16	High-affinity IgG and IgA antibodies are used to neutralize microbial toxins and animal venoms	253
	Summary	227	9-17	Binding of IgM to antigen on a pathogen's surface activates complement by the classical pathway	255
	Summary to Chapter 8	227	9-18	Two forms of C4 tend to be fixed at different sites on pathogen surfaces	256
	Questions	228	9-19	Complement activation by IgG requires the participation of two or more IgG molecules	257
	Chapter 9		9-20	Erythrocytes facilitate the removal of immune complexes from the circulation	258
	Immunity Mediated by B Cells and Antibodies	231	9-21	Fc γ receptors enable effector cells to bind and be activated by IgG bound to pathogens	258
	Antibody production by B lymphocytes	231	9-22	A variety of low-affinity Fc receptors are IgG-specific	260
9-1	B-cell activation requires cross-linking of surface immunoglobulin	232	9-23	An Fc receptor acts as an antigen receptor for NK cells	261
9-2	B-cell activation requires signals from the B-cell co-receptor	232	9-24	The Fc receptor for monomeric IgA belongs to a different family than the Fc receptors for IgG and IgE	262
9-3	Effective B cell-mediated immunity depends on help from CD4 T cells	234		Summary	263
9-4	Follicular dendritic cells in the B-cell area store and display intact antigens to B cells	235		Summary to Chapter 9	263
9-5	Antigen-activated B cells move close to the T-cell area to find a helper T _{FH} cell	236		Questions	264
9-6	The primary focus of clonal expansion in the medullary cords produces plasma cells secreting IgM	238		Chapter 10	
9-7	Activated B cells undergo somatic hypermutation and isotype switching in the specialized microenvironment of the primary follicle	239		Preventing Infection at Mucosal Surfaces	267
9-8	Antigen-mediated selection of centrocytes drives affinity maturation of the B-cell response in the germinal center	241	10-1	The communication functions of mucosal surfaces render them vulnerable to infection	267
9-9	The cytokines made by helper T cells determine how B cells switch their immunoglobulin isotype	243	10-2	Mucins are gigantic glycoproteins that endow the mucus with the properties to protect epithelial surfaces	269
9-10	Cytokines made by helper T cells determine the differentiation of antigen-activated B cells into plasma cells or memory cells	244	10-3	Commensal microorganisms assist the gut in digesting food and maintaining health	269
	Summary	245	10-4	The gastrointestinal tract is invested with distinctive secondary lymphoid tissues	272
	Antibody effector functions	245	10-5	Inflammation of mucosal tissues is associated with causation not cure of disease	273
9-11	IgM, IgG, and monomeric IgA protect the internal tissues of the body	246			

10-6	Intestinal epithelial cells contribute to innate immune responses in the gut	275	11-7	In the secondary immune response, memory B cells are activated whereas naive B cells are inhibited	300
10-7	Intestinal macrophages eliminate pathogens without creating a state of inflammation	276	11-8	Activation of the primary and secondary immune responses have common features	301
10-8	M cells constantly transport microbes and antigens from the gut lumen to gut-associated lymphoid tissue	277	11-9	Combinations of cell-surface markers distinguish memory T cells from naive and effector T cells	302
10-9	Gut dendritic cells respond differently to food, commensal microorganisms, and pathogens	278	11-10	Central and effector memory T cells recognize pathogens in different tissues of the body	304
10-10	Activation of B cells and T cells in one mucosal tissue commits them to defending all mucosal tissues	279	11-11	In viral infections, numerous effector CD8 T cells give rise to relatively few memory T cells	305
10-11	A variety of effector lymphocytes guard healthy mucosal tissue in the absence of infection	281	11-12	Immune-complex-mediated inhibition of naive B cells is used to prevent hemolytic anemia of the newborn	305
10-12	B cells activated in mucosal tissues give rise to plasma cells secreting IgM and IgA at mucosal surfaces	282	11-13	In the response to influenza virus, immunological memory is gradually eroded	306
10-13	Secretory IgM and IgA protect mucosal surfaces from microbial invasion	283		Summary	307
10-14	Two subclasses of IgA have complementary properties for controlling microbial populations	285		Vaccination to prevent infectious disease	308
10-15	People lacking IgA are able to survive, reproduce, and generally remain healthy	286	11-14	Protection against smallpox is achieved by immunization with the less dangerous cowpox virus	308
10-16	T _H 2-mediated immunity protects against helminth infections	288	11-15	Smallpox is the only infectious disease of humans that has been eradicated worldwide by vaccination	309
Summary to Chapter 10		290	11-16	Most viral vaccines are made from killed or inactivated viruses	310
Questions		292	11-17	Both inactivated and live-attenuated vaccines protect against poliovirus	311
Chapter 11			11-18	Vaccination can inadvertently cause disease	312
Immunological Memory and Vaccination	295		11-19	Subunit vaccines are made from the most antigenic components of a pathogen	313
Immunological memory and the secondary immune response		296	11-20	Invention of rotavirus vaccines took at least 30 years of research and development	313
11-1	Antibodies made in a primary immune response persist for several months and provide protection	296	11-21	Bacterial vaccines are made from whole bacteria, secreted toxins, or capsular polysaccharides	314
11-2	Low levels of pathogen-specific antibodies are maintained by long-lived plasma cells	297	11-22	Conjugate vaccines enable high-affinity antibodies to be made against carbohydrate antigens	315
11-3	Long-lived clones of memory B cells and T cells are produced in the primary immune response	297	11-23	Adjuvants are added to vaccines to activate and enhance the response to antigen	316
11-4	Memory B cells and T cells provide protection against pathogens for decades and even for life	299	11-24	Genome sequences of human pathogens have opened up new avenues for making vaccines	316
11-5	Maintaining populations of memory cells does not depend upon the persistence of antigen	299	11-25	The ever-changing influenza virus requires a new vaccine every year	318
11-6	Changes to the antigen receptor distinguish naive, effector, and memory B cells	300			

11-26	The need for a vaccine and the demands placed upon it change with the prevalence of disease	319	12-14	$V_{\gamma}V_{\gamma}1$ T-cell receptors recognize lipid antigens presented by CD1d	352
11-27	Vaccines have yet to be made against pathogens that establish chronic infections	322		Summary	354
11-28	Vaccine development faces greater public scrutiny than drug development	323		Restriction of $\alpha:\beta$ T cells by non-polymorphic MHC class I-like molecules	354
	Summary	324	12-15	CD1-restricted $\alpha:\beta$ T cells recognize lipid antigens of mycobacterial pathogens	354
Summary to Chapter 11		325	12-16	NKT cells are innate lymphocytes that detect lipid antigens by using $\alpha:\beta$ T-cell receptors	356
Questions		326	12-17	Mucosa-associated invariant T cells detect bacteria and fungi that make riboflavin	357
Chapter 12				Summary	359
Coevolution of Innate and Adaptive Immunity		329		Summary to Chapter 12	360
Regulation of NK-cell function by MHC class I and related molecules		330		Questions	361
12-1	NK cells express a range of activating and inhibitory receptors	330	Chapter 13		
12-2	The strongest receptor that activates NK cells is an Fc receptor	332	Failures of the Body's Defenses	365	
12-3	Many NK-cell receptors recognize MHC class I and related molecules	333	Evasion and subversion of the immune system by pathogens	365	
12-4	Immunoglobulin-like NK-cell receptors recognize polymorphic epitopes of HLA-A, HLA-B, and HLA-C	335	13-1	Genetic variation within some species of pathogens prevents effective long-term immunity	366
12-5	NK cells are educated to detect pathological change in MHC class I expression	336	13-2	Mutation and recombination allow influenza virus to escape from immunity	366
12-6	Different genomic complexes encode lectin-like and immunoglobulin-like NK-cell receptors	339	13-3	Trypanosomes use gene conversion to change their surface antigens	368
12-7	Human KIR haplotypes uniquely come in two distinctive forms	340	13-4	Herpesviruses persist in human hosts by hiding from the immune response	369
12-8	Cytomegalovirus infection induces proliferation of NK cells expressing the activating HLA-E receptor	341	13-5	Some pathogens sabotage or subvert immune defense mechanisms	371
12-9	Interactions of uterine NK cells with fetal MHC class I molecules affect reproductive success	342	13-6	Bacterial superantigens stimulate a massive but ineffective CD4 T-cell response	373
	Summary	345	13-7	Subversion of IgA action by bacterial IgA-binding proteins	374
Maintenance of tissue integrity by $\gamma:\delta$ T cells		347		Summary	375
12-10	$\gamma:\delta$ T cells are not governed by the same rules as $\alpha:\beta$ T cells	347	Inherited immunodeficiency diseases	375	
12-11	$\gamma:\delta$ T cells in blood and tissues express different $\gamma:\delta$ receptors	348	13-8	Rare primary immunodeficiency diseases reveal how the human immune system works	375
12-12	$V_{\gamma}9:V_{\gamma}2$ T cells recognize phosphoantigens presented on cell surfaces	350	13-9	Inherited immunodeficiency diseases are caused by dominant, recessive, or X-linked gene defects	377
12-13	$V_{\gamma}4:V_{\gamma}5$ T cells detect both virus-infected cells and tumor cells	351	13-10	Recessive and dominant mutations in the IFN- γ receptor cause diseases of differing severity	378
			13-11	Antibody deficiency leads to poor clearing of extracellular bacteria	379

13-12	Diminished production of antibodies also results from inherited defects in T-cell help	380	14-5	IgE has distinctive properties that contrast with those of IgG	406
13-13	Complement defects impair antibody-mediated immunity and cause immune-complex disease	381	14-6	IgE and FcεRI supply each mast cell with a diversity of antigen-specific receptors	407
13-14	Defects in phagocytes result in enhanced susceptibility to bacterial infection	382	14-7	FcεRII is a low-affinity receptor for IgE Fc regions that regulates the production of IgE by B cells	407
13-15	Defects in T-cell function result in severe combined immune deficiencies	383	14-8	Treatment of allergic disease with an IgE-specific monoclonal antibody	409
13-16	Some inherited immunodeficiencies lead to specific disease susceptibilities	385	14-9	Mast cells defend and maintain the tissues in which they reside	410
	Summary	386	14-10	Tissue mast cells orchestrate IgE-mediated reactions through the release of inflammatory mediators	411
	Acquired immune deficiency syndrome	386	14-11	Eosinophils are specialized granulocytes that release toxic mediators in IgE-mediated responses	413
13-17	HIV is a retrovirus that causes a slowly progressing chronic disease	388	14-12	Basophils are rare granulocytes that initiate T _H 2 responses and the production of IgE	415
13-18	HIV infects CD4 T cells, macrophages, and dendritic cells	388		Summary	415
13-19	In the twentieth century, most HIV-infected people progressed in time to get AIDS	389		IgE-mediated allergic disease	416
13-20	Genetic deficiency of the CCR5 co-receptor for HIV confers resistance to infection	391	14-13	Allergens are protein antigens, some of which resemble parasite antigens	416
13-21	HLA and KIR polymorphisms influence the progression to AIDS	392	14-14	Predisposition to allergic disease is influenced by genetic and environmental factors	418
13-22	HIV escapes the immune response and develops resistance to antiviral drugs by rapid mutation	393	14-15	IgE-mediated allergic reactions consist of an immediate response followed by a late-phase response	419
13-23	Clinical latency is a period of active infection and renewal of CD4 T cells	394	14-16	The effects of IgE-mediated allergic reactions vary with the site of mast-cell activation	420
13-24	HIV infection leads to immunodeficiency and death from opportunistic infections	395	14-17	Systemic anaphylaxis is caused by allergens in the blood	421
13-25	A minority of HIV-infected individuals make antibodies that neutralize many strains of HIV	396	14-18	Rhinitis and asthma are caused by inhaled allergens	423
	Summary	397	14-19	Urticaria, angioedema, and eczema are allergic reactions in the skin	424
	Summary to Chapter 13	398	14-20	Food allergies cause systemic effects as well as gut reactions	426
	Questions	398	14-21	Allergic reactions are prevented and treated by three complementary approaches	427
				Summary	428
				Summary to Chapter 14	428
				Questions	429
				Chapter 15	
				Transplantation of Tissues and Organs	433
				Allogeneic transplantation can trigger hypersensitivity reactions	433
Chapter 14					
	IgE-Mediated Immunity and Allergy	401			
14-1	Different effector mechanisms cause four distinctive types of hypersensitivity reaction	401			
	Shared mechanisms of immunity and allergy	403			
14-2	IgE-mediated immune responses defend the body against multicellular parasites	404			
14-3	IgE antibodies emerge at early and late times in the primary immune response	404			
14-4	Allergy is prevalent in countries where parasite infections have been eliminated	406			

15-1	Blood is the most common transplanted tissue	434	Hematopoietic cell transplantation	458	
15-2	Before blood transfusion, donors and recipients are matched for ABO and the Rhesus D antigens	434	15-20	Hematopoietic cell transplantation is a treatment for genetic diseases of blood cells	459
15-3	Incompatibility of blood group antigens causes type II hypersensitivity reactions	435	15-21	Allogeneic hematopoietic cell transplantation is the preferred treatment for many cancers	461
15-4	Hyperacute rejection of transplanted organs is a type II hypersensitivity reaction	436	15-22	After hematopoietic cell transplantation, the patient is attacked by alloreactive T cells in the graft	461
15-5	Anti-HLA antibodies can arise from pregnancy, blood transfusion, or previous transplants	437	15-23	HLA matching of donor and recipient is most important for hematopoietic cell transplantation	462
15-6	Transplant rejection and graft-versus-host disease are type IV hypersensitivity reactions	438	15-24	Minor histocompatibility antigens trigger alloreactive T cells in recipients of HLA-identical transplants	464
	Summary	439	15-25	Some GVHD helps engraftment and prevents relapse of malignant disease	465
	Transplantation of solid organs	440	15-26	NK cells also mediate graft-versus-leukemia effects	466
15-7	Organ transplantation involves procedures that inflame the donated organ and the transplant recipient	440	15-27	Hematopoietic cell transplantation can induce tolerance of a solid organ transplant	467
15-8	Acute rejection is a type IV hypersensitivity caused by effector T cells responding to HLA differences between donor and recipient	441		Summary	467
15-9	HLA differences between transplant donor and recipient activate numerous alloreactive T cells	442		Summary to Chapter 15	468
15-10	Chronic rejection of organ transplants is caused by a type III hypersensitivity reaction	443		Questions	469
15-11	Matching donor and recipient HLA class I and II allotypes improves the success of transplantation	445		Chapter 16	
15-12	Immunosuppressive drugs make allogeneic transplantation possible as routine therapy	445		Disruption of Healthy Tissue by the Adaptive Immune Response	473
15-13	Some treatments induce immunosuppression before transplantation	447	16-1	Every autoimmune disease resembles a type II, III, or IV hypersensitivity reaction	474
15-14	T-cell activation can be targeted by immunosuppressive drugs	448	16-2	Autoimmune diseases arise when tolerance to self antigens is lost	477
15-15	Alloreactive T-cell co-stimulation can be blocked with a soluble form of CTLA4	451	16-3	HLA is the dominant genetic factor affecting susceptibility to autoimmune disease	478
15-16	Blocking cytokine signaling can prevent alloreactive T-cell activation	452	16-4	HLA associations reflect the importance of T-cell tolerance in preventing autoimmunity	480
15-17	Cytotoxic drugs target the replication and proliferation of alloantigen-activated T cells	453	16-5	Binding of antibodies to cell-surface receptors causes several autoimmune diseases	481
15-18	Patients needing a transplant outnumber the available organs	455	16-6	Organized lymphoid tissue sometimes forms at sites inflamed by autoimmune disease	484
15-19	The need for HLA matching and immunosuppressive therapy varies with the organ transplanted	456	16-7	The antibody response to an autoantigen can broaden and strengthen by epitope spreading	485
	Summary	457	16-8	Intermolecular epitope spreading occurs in systemic autoimmune disease	487
			16-9	Intravenous immunoglobulin is a therapy for autoimmune diseases	489

16-10	Monoclonal antibodies that target TNF- α and B cells are used to treat rheumatoid arthritis	490	17-10	Vaccination against human papillomaviruses can prevent cervical and other genital cancers	519
16-11	Rheumatoid arthritis is influenced by genetic and environmental factors	491	17-11	Vaccination with tumor antigens can cause cancer to regress but it is unpredictable	520
16-12	Autoimmune disease can be an adverse side-effect of an immune response to infection	492	17-12	Monoclonal antibodies that interfere with negative regulators of the immune response can be used to treat cancer	521
16-13	Noninfectious environmental factors affect the development of autoimmune disease	494	17-13	T-cell responses to tumor cells can be improved with chimeric antigen receptors	522
16-14	Type 1 diabetes is caused by the selective destruction of insulin-producing cells in the pancreas	495	17-14	The antitumor response of $\gamma\delta$ T cells and NK cells can be augmented	524
16-15	Combinations of HLA class II allotypes confer susceptibility and resistance to type 1 diabetes	496	17-15	T-cell responses to tumors can be improved by adoptive transfer of antigen-activated dendritic cells	525
16-16	Celiac disease is a hypersensitivity to food that has much in common with autoimmune disease	498	17-16	Monoclonal antibodies are valuable tools for the diagnosis of cancer	526
16-17	Celiac disease is caused by the selective destruction of intestinal epithelial cells	498	17-17	Monoclonal antibodies against cell-surface antigens are increasingly used in cancer therapy	528
16-18	Senescence of the thymus and the T-cell population contributes to autoimmunity	501	Summary to Chapter 17		529
16-19	Autoinflammatory diseases of innate immunity	502	Questions		530
	Summary to Chapter 16	503			
	Questions	506			

Chapter 17

Cancer and Its Interactions With the Immune System 509

17-1	Cancer results from mutations that cause uncontrolled cell growth	510
17-2	A cancer arises from a single cell that has accumulated multiple mutations	510
17-3	Exposure to chemicals, radiation, and viruses facilitates progression to cancer	512
17-4	Certain common features distinguish cancer cells from normal cells	513
17-5	Immune responses to cancer have similarities with those to virus-infected cells	514
17-6	Allogeneic differences in MHC class I molecules enable cytotoxic T cells to eliminate tumor cells	515
17-7	Mutations acquired by somatic cells during oncogenesis can give rise to tumor-specific antigens	516
17-8	Cancer/testis antigens are a prominent type of tumor-associated antigen	517
17-9	Successful tumors evade and manipulate the immune response	518