Contents

PARTI	AN INTRODUCTION TO IMMUNOBIOLOGY AND INN	ATEIMMUNITY		
Chapter 1	Basic Concepts in Immunology	YTIMUMMIATA		
Chapter 2	Innate Immunity: The First Lines of Defense	37		
Chapter 3	The Induced Responses of Innate Immunity	75	onasi di kour polypapiloe chains.	
	Manager of Chapter 1. I respectively of Vienming			
PART II	THE RECOGNITION OF ANTIGEN	gi-3 The antibody m		
Chapter 4	Antigen Recognition by B-cell and T-cell Receptors	127		
Chapter 5	The Generation of Lymphocyte Antigen Receptors	157		
			myl ent assingmos spésnil biorionyl en l	
Chapter 6	Antigen Presentation to T Lymphocytes	201	adaptive immune system and the natural innate instructions.	
PART III	THE DEVELOPMENT OF MATURE LYMPHOCYTE RE	CEPTOR	Lymphocytes matthern the ponematros then congregate in lymphoid tissues thro	
	REPERTOIRES		Mosthrited agents addivided the sound has	
Chapter 7	Signaling Through Immune-System Receptors	239		
Chapter 8	The Development and Survival of Lymphocytes	275	nasarioci elouscii medello lasteli na elastino.	
			A Precinence of Allega prince disprise	
PART IV	THE ADAPTIVE IMMUNE RESPONSE	o ethologo pai St 9 vimumini svitgebb of		
Chapter 9	T Cell-Mediated Immunity	335		
Chapter 10	The Humoral Immune Response	387	The structure of the antibody molecule in	
Chapter 11	Dynamics of Adaptive Immunity	429		
Chapter 12	The Mucosal Immune System	465	recepton by reasonning its receptioners	0
	2.9 She allemative malburavia an amplification Joseph		esileipegalei Cotosaen Aec Tiethaseneriw	
PARTV	THE IMMUNE SYSTEM IN HEALTH AND DISEASE			
Chapter 13	Failures of Host Defense Mechanisms	509	inganyl heil by lytkie: bros knamoplavá blad T rapáris niemnápus nit bavisace alsogisnyd	
Chapter 14	Allergy and Allergic Diseases	571		
Chapter 15	Autoimmunity and Transplantation	611	noilibhteadainea beilthitheiseadaigmy.	
Chapter 16	Manipulation of the Immune Response	669		
Appendix I	Immunologist's Toolbox with Immunological Constants	717	Da dell-surface proteins of T della arm when	
Appendix II	CD Antigens	763	an effective response to antique.	
Appendix III	Cytokines and Their Receptors	779		
Appendix IV	Chemokines and Their Receptors	782		
Biographies	resquentide en la verifica in la	784	B-cell responses to most antigens.	
Glossary		786		
Index	District of the state of the st	823	mi ent of and acquired defects in the im	
mild CX	Chapter 3 section references	18 action references		

Detailed Contents

Pa	AN INTRODUCTION TO IMMUNO BIOLOGY AND INNATE IMMUNI		1-22	Understanding adaptive immune responses is important for the control of allergies, autoimmune disease, and the rejection of transplanted organs.	3
			1-23	Vaccination is the most effective means of controlling	3
Chap	ter 1 Basic Concepts in Immunology	1	Summ	infectious diseases.	3
Princ	ples of innate and adaptive immunity.	3		ary to Chapter 1.	3
1-1	The immune system recognizes infection and induces			al references.	3
	protective responses.	3		THE RECOGNITION OF ANTIGEN	AN
1-2	The cells of the immune system derive from precursors in the bone marrow.	4	Char	oter 2: Innate Immunity: The First Lines	
1-3	The myeloid lineage comprises most of the cells of the		BIU	of Defense	37
	innate immune system.	4	The fi	irst lines of defense.	3
1-4	The lymphoid lineage comprises the lymphocytes of the adaptive immune system and the natural killer cells of innate immunity.	8	2-1	Infectious diseases are caused by diverse living agents that replicate in their hosts.	3
1-5	Lymphocytes mature in the bone marrow or the thymus and then congregate in lymphoid tissues throughout the body.	9	2-2	Infectious agents must overcome innate host defenses to establish a focus of infection.	4:
1-6	Most infectious agents activate the innate immune system and induce an inflammatory response.	10	2-3	Epithelial surfaces of the body provide the first line of defense against infection.	4:
1-7	Pattern recognition receptors of the innate immune system		2-4	Epithelial cells and phagocytes produce several kinds of antimicrobial proteins.	4
1-8	provide an initial discrimination between self and nonself. Adaptive immune responses are initiated by antigen and	11	Summ	Could be a selected by the first three of the selection o	4
	antigen-presenting cells in secondary lymphoid tissues.	12	The c	omplement system and innate immunity.	48
1-9	Lymphocytes activated by antigen give rise to clones of antigen-specific effector cells that mediate adaptive immunity.	12	2-5	The complement system recognizes features of microbial	
1-10	Clonal selection of lymphocytes is the central principle of adaptive immunity.	13		surfaces and marks them for destruction by the deposition of C3b.	50
1-11	The structure of the antibody molecule illustrates the central puzzle of adaptive immunity.	14	2-6	The lectin pathway uses soluble receptors that recognize microbial surfaces to activate the complement cascade.	52
1-12	Each developing lymphocyte generates a unique antigen receptor by rearranging its receptor gene segments.	15	2-7	The classical pathway is initiated by activation of the C1 complex and is homologous to the lectin pathway.	55
1-13	Immunoglobulins bind a wide variety of chemical structures,		2-8	Complement activation is largely confined to the surface on which it is initiated.	56
	whereas the T-cell receptor is specialized to recognize foreign antigens as peptide fragments bound to proteins of the major histocompatibility complex.	16	2-9	The alternative pathway is an amplification loop for C3b formation that is accelerated by recognition of pathogens	
1-14	The development and survival of lymphocytes is determined	17	2-10	by properdin. Membrane and plasma proteins that regulate the formation	57
1-15	by signals received through their antigen receptors. Lymphocytes encounter and respond to antigen in the	17		and stability of C3 convertases determine the extent of complement activation under different circumstances.	59
1-16	peripheral lymphoid organs. Lymphocyte activation requires additional signals beyond	17	2-11	Complement developed early in the evolution of multicellular organisms.	61
1-17	Lymphocytes activated by antigen proliferate in the peripheral lymphoid organs, generating effector cells	21	2-12	Surface-bound C3 convertase deposits large numbers of C3b fragments on pathogen surfaces and generates C5	Gr.
Summa	and immunological memory.	22 25	2-13	Ingestion of complement-tagged pathogens by phagocytes is mediated by receptors for the bound complement proteins.	62
The ef	fector mechanisms of adaptive immunity.	25	2-14	The small fragments of some complement proteins initiate	qqë
1-18	Antibodies protect against extracellular pathogens		2-15	a local inflammatory response. The terminal complement proteins polymerize to form pores	64
	and their toxic products.	26		in membranes that can kill certain pathogens.	65
1-19	T cells orchestrate cell-mediated immunity and regulate B-cell responses to most antigens.	28	2-16	Complement control proteins regulate all three pathways of complement activation and protect the host from their	
1-20	CD4 and CD8 T cells recognize peptides bound to two	20	0	destructive effects.	66
1-21	different classes of MHC molecules. Inherited and acquired defects in the immune system result	29	Summa		71
'-'	in increased susceptibility to infection.	31		n references.	72

Section references.

Unap	ine induced Responses of Innate		Quest	ions.		121
	Immunity	75	Gener	al referen	nces.	122
Dette	re recognition by cells of the innete immune system	75	Sectio	n referen	ces.	122
3-1	After entering tissues, many pathogens are recognized, ingested, and killed by phagocytes.	75 76				
3-2	G-protein-coupled receptors on phagocytes link microbe recognition with increased efficiency of intracellular killing.	78	l Pa	rt II	THE RECOGNITION OF ANTIGI	EN
3-3	Pathogen recognition and tissue damage initiate an inflammatory response.	82	Chap	oter 4	Antigen Recognition by B-cell	407
24	Toll-like receptors represent an ancient pathogen-recognition				and T-cell Receptors	127
-	system.	85	The s	tructure	e of a typical antibody molecule.	128
3-5	Mammalian Toll-like receptors are activated by many different pathogen-associated molecular patterns.	85	4-1 4-2		tibodies consist of four polypeptide chains. oglobulin heavy and light chains are composed	129
3-6	TLR-4 recognizes bacterial lipopolysaccharide in association with the host accessory proteins MD-2 and CD14.	88		of cons	stant and variable regions.	130
3-7	TLRs activate the transcription factors NFkB, AP-1,		4-3		ntibody molecule can readily be cleaved into nally distinct fragments.	130
	and IRF to induce the expression of inflammatory cytokines and type I interferons.	89	4-4		munoglobulin molecule is flexible, especially at ge region.	131
3-8	The NOD-like receptors act as intracellular sensors of bacterial infection.	92	4-5	The do	mains of an immunoglobulin molecule have structures.	132
3-9	The RIG-I-like helicases detect cytoplasmic viral RNAs and stimulate interferon production.	94	Summ	the h6	indigentinos amentos energias anemies enolitoria	133
3-10	Activation of TLRs and NLRs triggers changes in gene expression in macrophages and dendritic cells that have far-reaching effects on the immune response.	96		nteraction fic antig	on of the antibody molecule with gen.	134
3-11	TLR signaling shares many components with Toll signaling in Drosophila.	97	4-6		ed regions of hypervariable sequence form the n-binding site.	134
3-12	TLR and NOD genes have undergone extensive diversification in both invertebrates and some primitive chordates.	98	4-7	Antibo	dies bind antigens via contacts with amino acids in but the details of binding depend upon the size ape of the antigen.	135
Summ	antiden presentation by WHO class I molecules	98	4-8		dies bind to conformational shapes on the surfaces	136
Induc	ed innate responses to infection.	99	4-9	A PROPERTY OF	n-antibody interactions involve a variety of forces.	136
3-13	Macrophages and dendritic cells activated by pathogens secrete a range of cytokines that have a variety of local	7-8 247	Summ	aru		138
	and distant effects.	99	Antiq	en reco	gnition by T cells.	138
3-14	Chemokines released by macrophages and dendritic cells recruit effector cells to sites of infection.	102	4-10	The T-c	cell receptor is very similar to a Fab fragment of oglobulin.	139
3-15	Cell-adhesion molecules control interactions between leukocytes and endothelial cells during an inflammatory	251	4-11	A T-cel	receptor recognizes antigen in the form of a ex of a foreign peptide bound to an MHC molecule.	140
3-16	response. Neutrophils make up the first wave of cells that cross the	103	4-12	There	are two classes of MHC molecules with distinct compositions but similar three-dimensional	
	blood vessel wall to enter an inflamed tissue.	105	G.	structu		141
3-17	TNF-α is an important cytokine that triggers local containment of infection but induces shock when	107	4-13	Peptide serve t	es are stably bound to MHC molecules, and also o stabilize the MHC molecule on the cell surface.	142
3-18	Cytokines released by macrophages and dendritic cells	253	4-14		lass I molecules bind short peptides of 8–10 amino y both ends.	143
3-19	Interferons induced by viral infection make several	109	4-15		ngth of the peptides bound by MHC class II les is not constrained.	145
3-20	NK cells are activated by interferon and macrophage-derived cytokines to serve as an early defense against certain		4-16	recepto	stal structures of several peptide:MHC:T-cell or complexes show a similar orientation of the eceptor over the peptide:MHC complex.	147
321	Intracellular infections. NK cells possess receptors for self molecules that prevent	113	4-17		04 and CD8 cell-surface proteins of T cells are d to make an effective response to antigen.	148
3-22	Their activation by uninfected cells. NK cells bear receptors that activate their effector function	113	4-18	The two	classes of MHC molecules are expressed itially on cells.	150
	in response to ligands expressed on infected cells or tumor cells.	117	4-19	A distin	ct subset of T cells bears an alternative receptor up of γ and δ chains.	151
HB	The NKG2D receptor activates a different signaling pathway from that of the other activating NK receptors.	117	Summa		C type of the mymac stroma selects a reperture of	152
TOTAL	Several lymphocyte subpopulations behave as innate-like	81-9		ary to Ch	apter 4.	152
	lymphocytes.	118	Questio	*	ed by the same and interest of the same property of the same and the s	153
Summa	Ty of shinit is identify at a soun has OHA and abiguing	120		al referen	ces.	154
Summa	ary to Chapter 3.	120	Section	reference	ces.	154

Chapt	er 5	The Generation of Lymphocyte Antigen Receptors	157	5-22	repertoi	ependent adaptive immunity based on a diversified re of immunoglobulin-like genes appeared abruptly artilaginous fishes.	190
		unoglobulin gene rearrangement.	158	5-23	Different	t species generate immunoglobulin diversity in ways.	192
5-1		oglobulin genes are rearranged in antibody- sing cells.	158	5-24		β and γ:δ T-cell receptors are present in	190
5-2	Compl	ete genes that encode a variable region are ated by the somatic recombination of separate	130	5-25	cartilagi	nous fish. ass I and class II molecules are also first found	194
	_	egments.	159		in the ca	artilaginous fishes.	195
5-3		e contiguous V gene segments are present at		Summ			195
		nmunoglobulin locus.	160		ary to Cha	pter 5.	196
5-4		ingement of V, D, and J gene segments is guided king DNA sequences.	161	Questi			197
5-5		action that recombines V, D, and J gene segments	101		al referenc		198
961	involve	s both lymphocyte-specific and ubiquitous nodifying enzymes.	162	Section	n reference	TLR-4 recognizes bacterial lipopolysaccharide in with the host accessory profeins MD-2 and CD10	198
5-6		versity of the immunoglobulin repertoire is ted by four main processes.	166	Chap		Antigen Presentation to T Lymphocytes	201
5-7		ultiple inherited gene segments are used in different nations.	166	The a		n of T-cell receptor ligands.	202
5-8	Variabl	e addition and subtraction of nucleotides at the		6-1		C class I and class II molecules deliver peptides	
		ns between gene segments contributes to the	167	0-1		ell surface from two intracellular compartments.	202
Cummo		ty of the third hypervariable region.	167	6-2		s that bind to MHC class I molecules are	
Summa	ry.		168	122		transported from the cytosol to the endoplasmic	004
T-cell r	ecepto	or gene rearrangment.	169	0.0	reticulun		204
5-9	8.8	cell receptor gene segments are arranged in a		6-3		for transport into the endoplasmic reticulum erated in the cytosol.	205
1-7	similar	pattern to immunoglobulin gene segments and are ged by the same enzymes.	169	6-4	Newly sy	ynthesized MHC class I molecules are retained adoptasmic reticulum until they bind a peptide.	207
5-10		eceptors concentrate diversity in the third ariable region.	171	6-5	Many vir	ruses produce immunoevasins that interfere with presentation by MHC class I molecules.	209
5-11		ell receptors are also generated by gene	170	6-6		presented by MHC class II molecules are	THE
Cummo		igement.	172			ed in acidified endocytic vesicles.	210
Summa	Cional	riation in immunoalabulin	173	6-7		riant chain directs newly synthesized MHC nolecules to acidified intracellular vesicles.	211
consta	nt regi		173	6-8		lized MHC class II-like molecule catalyzes of MHC class II molecules with peptides.	212
	the stru	nt classes of immunoglobulins are distinguished by acture of their heavy-chain constant regions.	174	6-9	presente	resentation allows exogenous proteins to be ed on MHC class I molecules by a restricted	
5-13		nstant region confers functional specialization antibody.	175	6-10		itigen-presenting cells. Inding of peptides by MHC molecules provides	214
5-14	Mature	naive B cells express both IgM and IgD at their	176	2.9	effective	antigen presentation at the cell surface.	215 216
5-15		embrane and secreted forms of immunoglobulin		Summa	ary.		210
	are ger	nerated from alternative heavy-chain transcripts.	177	The m	najor hist	ocompatibility complex and its function.	217
5-16 Summar	ADDITION	d IgA can form polymers.	178 179	6-11	Many pro	oteins involved in antigen processing and ation are encoded by genes within the MHC.	217
Second	darv di	versification of the antibody repertoire.	179	6-12		ein products of MHC class I and class II genes ly polymorphic.	220
5-17	Activati	on-induced cytidine deaminase (AID) introduces ons into genes transcribed in B cells.	180	6-13	MHC pol	lymorphism affects antigen recognition by T cells noting both peptide binding and the contacts	00.0
5-18	Somati	c hypermutation further diversifies the rearranged V of immunoglobulin genes.	182	6-14	between	T-cell receptor and MHC molecule. tive T cells recognizing nonself MHC molecules	222
		witching enables the same assembled V _H exon	VIET	0 17		abundant.	223
	to be a	ssociated with different C _H genes in the course of	a sign	6-15	Many T o	cells respond to superantigens.	226
		une response.	184	6-16		lymorphism extends the range of antigens to	35-6
Summar	y.		186			e immune system can respond.	227
Evoluti	on of t	he adaptive immune response.	186	6-17	and the same of th	of genes with specialized functions in immunity encoded in the MHC.	228
5-20	Some i	nvertebrates generate extensive diversity in a ire of immunoglobulin-like genes.	187	6-18	Specializ	ed MHC class I molecules act as ligands for ation and inhibition of NK cells.	230
5-21	Agnath	ans possess an adaptive immune system that omatic gene rearrangement to diversify receptors		6-19	The CD1	family of MHC class I-like molecules is encoded he MHC and presents microbial lipids to	Summ
		m LRR domains.	189			tricted T cells.	231

Summ	Plasmasijaoidideodeitomplarpmdumidabooplasmasel9	233	7-20		ine receptors of the hematopoietin family are	8-17
Summ	ary to Chapter 6.	233	Resec		iated with the JAK family of tyrosine kinases,	000
Questi	Diesentation by convening dending cells.	234	702		activate STAT transcription factors.	266
Genera	al references.	235	7-21	THE RESERVE AND ADDRESS OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TO T	ine signaling is terminated by a negative feedback	007
200	n references.	235	X	PO TEC	anism.	267
	B cells are nignly emcient at presenting anugers for	382	7-22		eceptors that induce apoptosis activate specialized	007
	THIBUODUUMIN SOSING SON OF DERIC		UIG		ellular proteases called caspases.	267
Por	THE DEVELOPMENT OF		7-23	The in	trinsic pathway of apoptosis is mediated by the	070
Fall			116	releas	e of cytochrome c from mitochondria.	270
	MATURE LYMPHOCYTE		Summa	ary.		270
	RECEPTOR REPERTOIRES		Summa	ary to C	hapter 7.	271
	Celf-adhesion molecules mediate mediate intendicine		Questi	ons.		272
	of naive I cells with antigen-presenting cells.		Genera	al refere	nces.	272
Chap	ter 7 Signaling Through Immune-System	11-6		referer		272
	Receptors	239	Occilor	ricicio	apier 10.	424
A	CD28-dependent co-stimulation of activated T cale					IVALUE .
	principles of signal transduction	220	Chap	ter 8	The Development and Survival of	Iqmyi
and p	ropagation.	239	Onap	toi o		275
75	Transmembrane receptors convert extracellular signals	9-13			Lymphocytes	213
	into intracellular biochemical events.	240	Devel	opmen	t of B lymphocytes.	276
72	Intracellular signal propagation is mediated by large			5019	1014 2015 21160 760 000 000 000 000 000 000 000 000 0	190
	multiprotein signaling complexes.	242	8-1		nocytes derive from hematopoietic stem cells in	076
西	Small G proteins act as molecular switches in many		1000		ne marrow.	276
	different signaling pathways.	243	8-2		development begins by rearrangement of the	070
34	Signaling proteins are recruited to the membrane by	392			-chain locus.	278
	a warriety of mechanisms.	244	8-3		e-B-cell receptor tests for successful production	
75	Ubiquitin conjugation of proteins can both activate				omplete heavy chain and signals for the transition	000
	and inhibit signaling responses.	245			ne pro-B cell to pre-B cell stage.	282
	The activation of some receptors generates		8-4		cell receptor signaling inhibits further heavy-chain	000
	small-molecule second messengers.	246	321		rearrangement and enforces allelic exclusion.	283
Summa	ZVBVINIBO ROKONIO JONICIO NAVOD ZIJEO LACIU SVISO.	247	8-5		cells rearrange the light-chain locus and express	004
	THE PROPERTY OF THE PARTY OF TH	61-6	322		rface immunoglobulin.	284
Antiqu	receptor signaling and lymphocyte activation.	247	8-6		ure B cells are tested for autoreactivity before they	005
777	Antigen receptors consist of variable antigen-binding		324	leave t	he bone marrow.	285
	mains associated with invariant chains that carry out		Summa	ary.		290
	the signaling function of the receptor.	247	325	Gileria	MINO AND NEWNY EXPRESSED SUITED IN MUDELLINES.	mmus
	Antigen recognition by the T-cell receptor and its co-receptors		The de	evelopi	ment of T lymphocytes in the thymus.	290
	leads to phosphorylation of ITAMs by Src-family kinases.	249	8-7	T-cell p	progenitors originate in the bone marrow, but all	indano.
	Phosphorylated ITAMs recruit and activate the tyrosine			the im	portant events in their development occur in	nilano I
	Tasse ZAP-70, which phosphorylates scaffold proteins			the thy	mus.	291
	that recruit the phospholipase PLC-γ.	251	8-8	T-cell p	precursors proliferate extensively in the thymus,	
	The activation of PLC-γ requires a co-stimulatory signal.	251		but mo	st die there.	294
	Activated PLC-γ generates the second messengers		8-9	Succe	ssive stages in the development of thymocytes are	
	diacylglycerol and inositol trisphosphate.	252		marke	d by changes in cell-surface molecules.	294
THE	entry activates the transcription factor NFAT.	253	8-10	Thymo	cytes at different developmental stages are found	
	Pas activation stimulates the mitogen-activated protein				nct parts of the thymus.	297
	Minase (MAPK) relay and induces expression of the		8-11	T cells	with $\alpha:\beta$ or $\gamma:\delta$ receptors arise from a common	BINU
	transcription factor AP-1.	253		proger	nitor.	298
THE REAL PROPERTY.	Protein kinase C activates the transcription factors NFkB		8-12	T cells	expressing particular γ - and δ -chain V regions arise	relieb Pa
	and AP-1. Cytotoxic T cells can included and area ellectronic Toxotoxic	256	100		rdered sequence early in life.	299
PHS.	The cell-surface protein CD28 is a co-stimulatory receptor		8-13	Succes	ssful synthesis of a rearranged \(\beta \) chain allows	1700
	for naive T cells.	257			duction of a pre-T-cell receptor that triggers cell	440
	The logic of B-cell receptor signaling is similar to that of			prolifer	ation and blocks further β-chain gene	
	Tree receptor signaling, but some of the signaling	200	11-13	rearrar	ngement.	301
	components are specific to B cells.	258	8-14	T-cell c	x-chain genes undergo successive rearrangements	944
	TAMs are also found in other receptors on leukocytes	000	11-14	until po	sitive selection or cell death intervenes.	304
	that signal for cell activation.	260	Summa	ry.	HISTORY DE LICENS HILL DILIT SHOOT I SAIRLI TO A RUE SHI	305
	receptors on lymphocytes help regulate	000	11-15	Repeal	BOULDING SERVICES HER AUTHORISM TO A SERVICE BANGE SERVICES OF THE SERVICES OF	A CONTRACTOR OF THE PARTY OF TH
	immune responses.	260	Positiv	e and	negative selection of T cells.	305
3mm	THE THE RESIDENCE OF THE PROPERTY OF THE PARTY OF THE PAR	263	8-15	The MI	HC type of the thymic stroma selects a repertoire of	7076
		00.0	DIEYO		T cells that can recognize foreign antigens	20
	receptors and signaling pathways.	264			ted by the same MHC type.	306
	Common and their receptors fall into distinct families		8-16	Only th	ymocytes whose receptors interact with self-peptide:	452
	structurally related proteins.	264			C complexes can survive and mature.	307

8-17	Positive selection acts on a repertoire of T-cell receptors with inherent specificity for MHC molecules.	308	9-7	Plasmacytoid dendritic cells produce abundant type I interferons and may act as helper cells for antigen	
8-18	Positive selection coordinates the expression of CD4	1-157		presentation by conventional dendritic cells.	349
Raign	or CD8 with the specificity of the T-cell receptor and the potential effector functions of the T cell.	308	9-8	Macrophages are scavenger cells that can be induced by pathogens to present foreign antigens to naive T cells.	350
8-19	Thymic cortical epithelial cells mediate positive selection		9-9	B cells are highly efficient at presenting antigens that	
267	of developing thymocytes.	310		bind to their surface immunoglobulin.	351
8-20	T cells that react strongly with ubiquitous self antigens	7-23	Summ	nary.	352
	are deleted in the thymus.	311		in the cardinations against the cardinations of the cardination of the cardination of the cardination of the cardination of th	
8-21	Negative selection is driven most efficiently by bone marrow derived antigen-presenting cells.	313		ing of naive T cells by pathogen-activated ritic cells.	353
8-22	The specificity and/or the strength of signals for negative and positive selection must differ.	314	9-10	Cell-adhesion molecules mediate the initial interaction of naive T cells with antigen-presenting cells.	353
Summ	No denter a little cantience de la constant de la c	315	9-11	Antigen-presenting cells deliver three kinds of signals for	gatta
Curvi	ival and maturation of hymphocytoc in navinhard		0.40	the clonal expansion and differentiation of naive T cells.	354
	ival and maturation of lymphocytes in peripheral hoid tissues.	316	9-12	CD28-dependent co-stimulation of activated T cells induces expression of the T-cell growth factor interleukin-2	
8-23	Different lymphocyte subsets are found in particular	Chapt		and the high-affinity IL-2 receptor.	355
0-20	locations in peripheral lymphoid tissues.	316	9-13	Signal 2 can be modified by additional co-stimulatory	
8-24	The development of peripheral lymphoid tissues is	alous/3		pathways.	356
C-CI	controlled by lymphoid tissue inducer cells and proteins		9-14	Antigen recognition in the absence of co-stimulation	
	of the tumor necrosis factor family.	317	242	leads to functional inactivation or clonal deletion of	357
8-25	The homing of lymphocytes to specific regions of	IAZ	0.15	peripheral T cells. Proliferating T cells differentiate into effector T cells that	337
Section	peripheral lymphoid tissues is mediated by chemokines.	319	9-15	do not require co-stimulation to act.	358
8-26	Lymphocytes that encounter sufficient quantities of self		9-16	CD8 T cells can be activated in different ways to become	
	antigens for the first time in the periphery are eliminated or inactivated.	320		cytotoxic effector cells.	359
8-27	Immature B cells arriving in the spleen turn over rapidly	020	9-17	CD4 T cells differentiate into several subsets of functionally	
0-21	and require cytokines and positive signals through the			different effector cells.	360
	B-cell receptor for maturation and survival.	321	9-18	Various forms of signal 3 induce the differentiation of	
8-28	B-1 cells and marginal zone B cells are distinct B-cell			naive CD4 T cells down distinct effector pathways.	362
	subtypes with unique antigen receptor specificity.	322	9-19	Regulatory CD4 T cells are involved in controlling	004
8-29	T-cell homeostasis in the periphery is regulated by	0-8	28-0	adaptive immune responses.	364
COS	cytokines and self-MHC interactions.	324	Summ	ary.	365
Summ		325	Gene	ral properties of effector T cells and their cytokines.	366
	ary to Chapter 8.	325		Effector T-cell interactions with target cells are initiated	0.0
Questi		329	9-20	by antigen-nonspecific cell-adhesion molecules.	366
	al references.	329	9-21	An immunological synapse forms between effector T cells	p.y
Section	n references.	329	251	and their targets to regulate signaling and to direct the release of effector molecules.	367
			9-22	The effector functions of T cells are determined by the	OFT
Par	THE ADAPTIVE IMMUNE			array of effector molecules that they produce.	369
	RESPONSE		9-23	Cytokines can act locally or at a distance.	370
	Transpering de la different developmental stages are found.		9-24	T cells express several TNF-family cytokines as trimeric	
01	in distinct parts of the thymus.	005		proteins that are usually associated with the cell surface.	371
Chap	ter 9 T Cell-Mediated Immunity	335	Summ	ary.	372
Entry	of naive T cells and antigen-presenting cells into		T coll	-mediated cytotoxicity.	372
	heral lymphoid organs.	337	0.30		312
9-1	Naive T cells migrate through peripheral lymphoid tissues,		9-25	Cytotoxic T cells can induce target cells to undergo	272
0 1	sampling the peptide:MHC complexes on dendritic		0.00	programmed cell death.	373
	cell surfaces.	337	9-26	Cytotoxic effector proteins that trigger apoptosis are contained in the granules of CD8 cytotoxic T cells.	374
9-2	Lymphocyte entry into lymphoid tissues depends on		9-27	Cytotoxic T cells are selective and serial killers of targets	0/4
	chemokines and adhesion molecules.	338	3-21	expressing a specific antigen.	376
9-3	Activation of integrins by chemokines is responsible for	000	9-28	Cytotoxic T cells also act by releasing cytokines.	377
	the entry of naive T cells into lymph nodes.	339	Summa	That signal to the contract of	377
9-4	T-cell responses are initiated in peripheral lymphoid	342	Son	Inhibitiony receptors and lympicities y tessingle regulated that the	- BEAN
0.5	Organs by activated dendritic cells.	342	Macro	phage activation by T _H 1 cells.	377
9-5	Dendritic cells process antigens from a wide array of pathogens.	344	9-29	T _H 1 cells have a central role in macrophage activation.	378
9-6	Pathogen-induced TLR signaling in immature dendritic		9-30	Activation of macrophages by T _H 1 cells promotes	- Hara
300	cells induces their migration to lymphoid organs and		1 230	microbial killing and must be tightly regulated to avoid	PERM
	enhances antigen processing.	347		tissue damage.	378
				- College - Smith Tipelis.	

	Tell cells coordinate the host response to intracellular mathogens.	379		estruction of antibody-coated pathogens via ceptors.	417
Summa	matory responses to viral infections.	380	10-21	The Fc receptors of accessory cells are signaling receptors	
Summe	any to Chapter 9.	381	10-21	specific for immunoglobulins of different classes.	418
	TELETERCES.	382	10-22	Fc receptors on phagocytes are activated by antibodies bound to the surface of pathogens and enable the	
		382		phagocytes to ingest and destroy pathogens.	419
	melerences.	302	10-23	Fc receptors activate NK cells to destroy antibody-coated targets.	420
	The Humoral Immune Response	387	10-24	Mast cells and basophils bind IgE antibody via the	
Best	activation by helper T cells.	388	10-25	high-affinity Fcɛ receptor. IgE-mediated activation of accessory cells has an	421
	The humoral immune response is initiated when B cells		Cumm	important role in resistance to parasite infection.	422
	that bind antigen are signaled by helper T cells or by certain	000	Summa		423
	microbial antigens alone.	389		ary to Chapter 10.	424
TOP	B-cell responses are enhanced by co-ligation of the B-cell		Questi	ons.	425
	receptor and B-cell co-receptor by antigen and complement	000	Genera	al references.	426
	fragments on microbial surfaces.	389	Section	references.	426
	Helper T cells activate B cells that recognize the same	390		Inneggia participation and the participation	
	Ticells make membrane-bound and secreted molecules	0-01	Oham	tou 44 Dynamics of Adomtive Income the	400
	that activate B cells.	391	14.10	ter 11 Dynamics of Adaptive Immunity	429
105	B cells that encounter their antigens migrate toward the boundaries between B-cell and T-cell areas in secondary		The co	ourse of the immune response to infection.	430
	lymphoid tissues.	392	11-1	The course of an infection can be divided into several distinct phases.	430
	Antibody-secreting plasma cells differentiate from activated B cells.	395	11-2	The nonspecific responses of innate immunity are necessary for an adaptive immune response to be initiated.	432
	The second phase of a primary B-cell immune response		11-3	Cytokines made during infection can direct differentiation	60.
	when activated B cells migrate into follicles and moliferate to form germinal centers.	396		of CD4 T cells toward the T _H 17 subset.	434
mes	Germinal center B cells undergo V-region somatic	000	11-4	T _H 1 and T _H 2 cells are induced by cytokines generated in response to different pathogens.	435
	in antigen are selected.	398	11-5	CD4 T-cell subsets can cross-regulate each other's differentiation.	437
ME-S	switching in thymus-dependent antibody responses expression of CD40 ligand by helper T cells and	400	11-6	Effector T cells are guided to sites of infection by chemokines and newly expressed adhesion molecules.	439
	Ligation of CD40 and prolonged contact with T follicular	400	11-7	Differentiated effector T cells are not a static population	611
	melber cells is required to sustain germinal center B cells.	402		but continue to respond to signals as they carry out their effector functions.	441
	Surviving germinal center B cells differentiate into either masma cells or memory cells.	402	11-8	Primary CD8 T-cell responses to pathogens can occur in the absence of CD4 T-cell help.	442
MEHIZ	Some bacterial antigens do not require T-cell help to mouce B-cell responses.	404	11-9	Antibody responses develop in lymphoid tissues under	012
W-13	B-cell responses to bacterial polysaccharides do not require peptide-specific T-cell help.	405	11-10	the direction of T _{FH} cells. Antibody responses are sustained in medullary cords	444
Shirms	The population operation in the participation of th	407		and bone marrow.	445
		578	11-11	The effector mechanisms used to clear an infection depend on the infectious agent.	445
THE DI	butions and functions of immunoglobulin	408	11-12	Resolution of an infection is accompanied by the death of most of the effector cells and the generation of	
10-14	Artibodies of different classes operate in distinct places	400		memory cells.	447
1045	and have distinct effector functions. Transport proteins that bind to the Fc regions of antibodies	408	Summa	ry.	448
	carry particular isotypes across epithelial barriers.	409	Immur	nological memory.	448
	High-affinity IgG and IgA antibodies can neutralize bacterial toxins.	412	11-13	Immunological memory is long-lived after infection or vaccination.	449
	High-affinity IgG and IgA antibodies can inhibit the mectivity of viruses.	413	11-14	Memory B-cell responses differ in several ways from those of naive B cells.	450
TE-TIE	Antibodies can block the adherence of bacteria to host	413	11-15	Repeated immunization leads to increasing affinity of	622
	Antibody:antigen complexes activate the classical			antibody due to somatic hypermutation and selection by antigen in germinal centers.	451
	way of complement by binding to C1q.	414	11.10		701
	Complement receptors are important in the removal		11-16	Memory T cells are increased in frequency compared with naive T cells specific for the same antigen, and have	
	immune complexes from the circulation.	416		distinct activation requirements and cell-surface proteins	450
	The same of the sa	417		that distinguish them from effector T cells.	452

11-17	Memory T cells are heterogeneous and include central	155	Summ		uljeostate oti seponesta the disesta esponesta de disesta esponesta de la T	502
11 10	memory and effector memory subsets.	455	Summ	ary to Cl	napter 12.	503
11-18	CD4 T-cell help is required for CD8 T-cell memory and involves CD40 and IL-2 signaling.	456	Questi	Macror	hages are scavenger cells that can be included at their	504
11-19	In immune individuals, secondary and subsequent responses are mainly attributable to memory lymphocytes.	458		al referer n referen	DESTRUCTED FOR DESCRIPTION OF THE PROPERTY OF	50 ⁴
Summa	and the property of the property of the personal party of the property of the property of the property of the property of the personal party of the person	459		bind to	their surface immunoglobulin.	
	ary to Chapter 11.	460	Staring			
Questi	and male that in the limit we will be a second of the seco		Da	rtV	THE IMMINITE CYCTEM IN	
	n references.	461	Fa		THE IMMUNE SYSTEM IN HEALTH AND DISEASE	
8-22	The specificate period vice session to abstract session to a session to the session of the sessi	10-25	3886	Cell-ad	nesion molecules mallele Threigher introduction II	95-E
Segmina	ter 12 The Mucosal Immune System	465	341		Failures of Host Defense Mechanisms	509
	rganization of the mucosal system.	465	Evasi		subversion of immune defenses.	509
12-1	The mucosal immune system protects the internal surfaces of the body.	465	13-1	Antige	nic variation allows pathogens to escape from ity.	510
12-2	The mucosal immune system may be the original vertebrate immune system.	468	13-2		viruses persist <i>in vivo</i> by ceasing to replicate until ity wanes.	512
12-3	Cells of the mucosal immune system are located both in anatomically defined compartments and scattered		13-3	Some	pathogens resist destruction by host defense nisms or exploit them for their own purposes.	514
12-4	throughout mucosal tissues. The intestine has distinctive routes and mechanisms of	468	13-4	Immun	osuppression or inappropriate immune responses ntribute to persistent disease.	515
12-5	antigen uptake. The mucosal immune system contains large numbers of	472	13-5	Immun	e responses can contribute directly to	358
12-6	effector lymphocytes even in the absence of disease. The circulation of lymphocytes within the mucosal immune	473	13-6		enesis. story T cells can affect the outcome of infectious	518
120	system is controlled by tissue-specific adhesion molecules and chemokine receptors.	474	Summa	diseas ary.	The second phase of a primary B-cell immune res	518 519
12-7	Priming of lymphocytes in one mucosal tissue can induce protective immunity at other mucosal surfaces.	475	Immu	nodefic	iency diseases.	519
12-8	Unique populations of dendritic cells control mucosal immune responses.	476	13-7		ry of repeated infections suggests a diagnosis of odeficiency.	520
12-9	The intestinal lamina propria contains antigen-experienced T cells and populations of unusual innate-type lymphocytes.	324	13-8	Primar	y immunodeficiency diseases are caused by ed gene defects.	520
12-10	The intestinal epithelium is a unique compartment of the immune system.	479	13-9	Defects	s in T-cell development can result in severe ned immunodeficiencies.	522
12-11	Secretory IgA is the class of antibody associated with the mucosal immune system.	482	13-10		an also be due to defects in the purine salvage	523
12-12	IgA deficiency is common in humans but may be	485	13-11	Defects	s in antigen receptor gene rearrangement can	524
Summa	compensated for by secretory IgM. ary.	486	13-12	Defects	s in signaling from T-cell antigen receptors can	288
	ucosal response to infection and regulation	11-10	13-13	Genetic	severe immunodeficiency. c defects in thymic function that block T-cell	524
12-13	cosal immune responses. Enteric pathogens cause a local inflammatory response	486	13-14	- Authoritie	oment result in severe immunodeficiencies. s in B-cell development result in deficiencies in	525
12-14	and the development of protective immunity. The outcome of infection by intestinal pathogens is	486			ly production that cause an inability to clear llular bacteria.	527
	determined by a complex interplay between the microorganism and the host immune response.	489	13-15		e deficiencies can be caused by defects in B-cell activation and function.	528
12-15	The mucosal immune system must maintain a balance between protective immunity and homeostasis to a large		13-16	Defects	in complement components and complement- ory proteins cause defective humoral immune	
	number of different foreign antigens.	491			and tissue damage.	532
12-16	The healthy intestine contains large quantities of bacteria but does not generate potentially harmful immune	338	13-17	Defects	in phagocytic cells permit widespread bacterial ns.	533
	responses against them.	493	13-18	Mutatio	n in the molecular regulators of inflammation can	
12-17	Full immune responses to commensal bacteria provoke intestinal disease.	497	Summar 413		uncontrolled inflammatory responses that result in lammatory disease.	536
12-18	Intestinal helminths provoke strong T _H 2-mediated immune responses.	498	13-19		rmal pathways for host defense against intracellular are pinpointed by genetic deficiencies of IFN-γ	
12-19	Other eukaryotic parasites provoke protective immunity and pathology in the gut.	501	13-20	and IL-	12 and their receptors. d lymphoproliferative syndrome is associated with	538
12-20	The mucosal immune system has to compromise between suppression and activation of an immune response.	501	714	fatal inf	ection by Epstein–Barr virus and with the ment of lymphomas.	539
				14 5	CONTRACTOR OF THE PROPERTY OF	

13-21	Genetic abnormalities in the secretory cytotoxic pathway of lymphocytes cause uncontrolled lymphoproliferation		14-8	Eosinophils and basophils cause inflammation and tissue damage in allergic reactions.	585
	and inflammatory responses to viral infections.	539	14-9	IgE-mediated allergic reactions have a rapid onset but	J. 731
13-22	Hematopoietic stem cell transplantation or gene therapy can be useful to correct genetic defects.	541	14-10	can also lead to chronic responses. Allergen introduced into the bloodstream can cause	587
13-23	Secondary immunodeficiencies are major predisposing causes of infection and death.	iolide5		anaphylaxis.	589
Summa		542 543	14-11	Allergen inhalation is associated with the development of rhinitis and asthma.	591
Acqui	red immune deficiency syndrome.	543	14-12	A genetically determined defect in the skin's barrier function increases the risk of atopic eczema.	592
		343	14-13	Allergy to particular foods causes systemic reactions as	002
13-24	Most individuals infected with HIV progress over time to AIDS.	545		well as symptoms limited to the gut.	594
13-25	HIV is a retrovirus that infects CD4 T cells, dendritic cells, and macrophages.	547	14-14	IgE-mediated allergic disease can be treated by inhibiting the effector pathways that lead to symptoms or by	
13-26	Genetic variation in the host can alter the rate of	549		desensitization techniques that aim at restoring tolerance to the allergen.	595
10.07	progression of disease.	549	Summa	ary.	597
13-27	A genetic deficiency of the co-receptor CCR5 confers resistance to HIV infection in vivo.	549	Non-lo	E-mediated allergic diseases.	598
13-28	HIV RNA is transcribed by viral reverse transcriptase		14-15	Innocuous antigens can cause type II hypersensitivity	RITAL
	into DNA that integrates into the host-cell genome.	551	1.T.10	reactions in susceptible individuals by binding to the	
13-29	Replication of HIV occurs only in activated T cells.	551		surfaces of circulating blood cells.	598
13-30	Lymphoid tissue is the major reservoir of HIV infection.	554	14-16	Systemic disease caused by immune-complex formation	
13-31	An immune response controls but does not eliminate HIV.	554		can follow the administration of large quantities of poorly	754
13-32	The destruction of immune function as a result of HIV			catabolized antigens.	598
	infection leads to increased susceptibility to opportunistic infection and eventually to death.	556	14-17	Hypersensitivity reactions can be mediated by T _H 1 cells and CD8 cytotoxic T cells.	600
13-33	Drugs that block HIV replication lead to a rapid decrease		14-18	Celiac disease has features of both an allergic response	SQLEE
	in titer of infectious virus and an increase in CD4 T cells.	557	644	and autoimmunity.	603
113-34	HIV accumulates many mutations in the course of infection,		Summa	THE SECTION OF STATISTICS AND THE PROPERTY OF STREET AND INCIDENCE.	605
	and drug treatment is soon followed by the outgrowth of	0	Summa	ry to Chapter 14.	606
	drug-resistant variants.	559	Questio	ns.ansier of protective immunity.	606
113-35	Vaccination against HIV is an attractive solution but	500	Genera	I references.	607
	poses many difficulties.	560	Section	references.	607
113-36	Prevention and education are one way in which the	E61		* Assessife//Perghannenusphosesia terhanenerusa ne	
_	spread of HIV and AIDS can be controlled.	561	<u> </u>	Cross-reactivity between foreign regleculasions netering	00426
Summa	The state of the s	562	Cnapt	er 15 Autoimmunity and Transplantation	611
	ary to Chapter 13.	562	The m	aking and breaking of self-tolerance.	611
Questio		563	15-1	A critical function of the immune system is to discriminate	20.2
	I references.	564 564	188	self from nonself.	612
COOLIOI	nodies and mell lies as research and mellon and statement.	793	15-2	Multiple tolerance mechanisms normally prevent autoimmunity.	613
Chapt	ter 14 Allergy and Allergic Diseases	571	15-3	Central deletion or inactivation of newly formed lymphocytes is the first checkpoint of self-tolerance.	614
InF an	d IgE-mediated allergic diseases.	573	15-4	Lymphocytes that bind self antigens with relatively low	53.0
14-1	Sensitization involves class switching to IgE production	ar784	Appe	affinity usually ignore them but in some circumstances become activated.	616
	on first contact with an allergen.	573	15-5	Antigens in immunologically privileged sites do not induce	
14-2	Allergens are usually delivered transmucosally at low dose, a route that favors IgE production.	575		immune attack but can serve as targets.	617
14-3	Genetic factors contribute to the development of IgE- mediated allergic disease.	577	15-6	Autoreactive T cells that express particular cytokines may be nonpathogenic or may suppress pathogenic	619
14-4	Environmental factors may interact with genetic	729	655	lymphocytes.	019
	susceptibility to cause allergic disease.	579	15-7	Autoimmune responses can be controlled at various stages by regulatory T cells.	619
14-5	Regulatory T cells can control allergic responses.	581	Summa	ry.	621
Summa	ry. To scopy and maging. Vaccines can be based on attenuated between one addition.	582	A		600
	or machaniama in leE madiated allerais readings	E00		nmune diseases and pathogenic mechanisms.	622
14-6	or mechanisms in IgE-mediated allergic reactions. Most IgE is cell-bound and engages effector mechanisms	582	15-8	Specific adaptive immune responses to self antigens can cause autoimmune disease.	622
0008	of the immune system by different pathways from those of other antibody isotypes.	583	15-9	Autoimmune diseases can be classified into clusters that are typically either organ-specific or systemic.	623
14-7	Mast cells reside in tissues and orchestrate allergic		15-10	Multiple components of the immune system are typically	
001	reactions.	583		recruited in autoimmune disease.	624

15-11	Chronic autoimmune disease develops through positive feedback from inflammation, inability to clear the self	455	15-38 Summa	The fetus is an allograft that is tolerated repeatedly.	661
	antigen, and a broadening of the autoimmune response.	625		ary to Chapter 15.	663
15-12	Both antibody and effector T cells can cause tissue damage in autoimmune disease.	629	Questi	Hamptonipile stem on transmight steen and anietonomic and transmight transmight the steen and anietonomic and transmight	664
15-13	Autoantibodies against blood cells promote their destruction.	631	Section	n references.	665
15-14	The fixation of sublytic doses of complement to cells in tissues stimulates a powerful inflammatory response.	632	Chap	ter 16 Manipulation of the Immune Response	669
15-15	Autoantibodies against receptors cause disease by stimulating or blocking receptor function.	632	Treatn	nent of unwanted immune responses.	669
15-16	Autoantibodies against extracellular antigens cause inflammatory injury by mechanisms akin to type II and	002	16-1	Corticosteroids are powerful anti-inflammatory drugs that alter the transcription of many genes.	670
15-17	type III hypersensitivity reactions. T cells specific for self antigens can cause direct tissue	632	16-2	Cytotoxic drugs cause immunosuppression by killing dividing cells and have serious side-effects.	671
Summa	injury and sustain autoantibody responses.	635 638	16-3	Cyclosporin A, tacrolimus (FK506), and rapamycin (sirolimus) are powerful immunosuppressive agents that	
Julillia	all your acces of the body	000		interfere with T-cell signaling.	671
	enetic and environmental basis of autoimmunity.	639	16-4	Antibodies against cell-surface molecules can be used to eliminate lymphocyte subsets or to inhibit lymphocyte	
15-18	Autoimmune diseases have a strong genetic component.	639		function.	674
15-19	Several approaches have given us insight into the genetic basis of autoimmunity.	640	16-5	Antibodies can be engineered to reduce their immunogenicity in humans.	674
15-20	Many genes that predispose to autoimmunity fall into categories that affect one or more of the mechanisms of tolerance.	642	16-6	Monoclonal antibodies can be used to prevent allograft rejection.	675
15-21	A defect in a single gene can cause autoimmune disease.	643	16-7	Depletion of autoreactive lymphocytes can treat autoimmune disease.	677
15-22	MHC genes have an important role in controlling susceptibility to autoimmune disease.	644	16-8	Biologic agents that block TNF-α or IL-1 can alleviate autoimmune diseases.	678
15-23	Genetic variants that impair innate immune responses can predispose to T cell-mediated chronic inflammatory	Sumn	16-9	Biologic agents can block cell migration to sites of inflammation and reduce immune responses.	679
15.04	disease.	647	16-10	Blockade of co-stimulatory pathways that activate lymphocytes can be used to treat autoimmune disease.	680
15-24 15-25	External events can initiate autoimmunity. Infection can lead to autoimmune disease by providing	648	16-11	Some commonly used drugs have immunomodulatory properties.	681
15-26	an environment that promotes lymphocyte activation. Cross-reactivity between foreign molecules on pathogens and self molecules can lead to anti-self	649	16-12	Controlled administration of antigen can be used to manipulate the nature of an antigen-specific response.	681
	responses and autoimmune disease.	649	Summa	ry.	682
15-27	Drugs and toxins can cause autoimmune syndromes.	651			000
15-28	Random events may be required for the initiation of autoimmunity.	651	A SAME I	the immune response to attack tumors. The development of transplantable tumors in mice led	682
Summa	ary. Ineverg vilamon amainericem econorelot elgifluM	651		to the discovery of protective immune responses to tumors.	684
AUD-CON.	nses to alloantigens and transplant rejection.	652	16-14	Tumors are 'edited' by the immune system as they evolve and can escape rejection in many ways.	684
15-29	Graft rejection is an immunological response mediated primarily by T cells.	652	16-15	Tumor-specific antigens can be recognized by T cells and form the basis of immunotherapies.	687
15-30	Transplant rejection is caused primarily by the strong immune response to nonself MHC molecules.	653	16-16	Monoclonal antibodies against tumor antigens, alone or linked to toxins, can control tumor growth.	691
15-31	In MHC-identical grafts, rejection is caused by peptides from other alloantigens bound to graft MHC molecules.	654	16-17	Enhancing the immune response to tumors by vaccination holds promise for cancer prevention and therapy.	693
15-32	There are two ways of presenting alloantigens on the transplanted donor organ to the recipient's		16-18	Checkpoint blockade can augment immune responses	14-3
45.00	T lymphocytes.	655	Summa	to existing tumors.	694
15-33	Antibodies that react with endothelium cause hyperacute graft rejection.	657		Susceptionity to cause aliergic disease.	533
15-34	Late failure of transplanted organs is caused by chronic injury to the graft.	658	16-19	ng infectious diseases with vaccination. Vaccines can be based on attenuated pathogens or	697
15-35	A variety of organs are transplanted routinely in clinical medicine.	659	16-20	material from killed organisms. Most effective vaccines generate antibodies that prevent	698
15-36	The converse of graft rejection is graft-versus-host disease.	659		the damage caused by toxins or that neutralize the pathogen and stop infection.	699
15-37	Regulatory T cells are involved in alloreactive immune responses.	661	16-21	Effective vaccines must induce long-lasting protection while being safe and inexpensive.	700
	The state of the s			Population	

16-22	Live-attenuated viral vaccines are usually more potent		Isolat	tion of ly	mphocytes.	739
	than 'killed' vaccines and can be made safer by the use of recombinant DNA technology.	700	A-20		n of peripheral blood lymphocytes by lypaque TM gradient.	739
16-23	Live-attenuated vaccines can be developed by selecting		A-21		n of lymphocytes from tissues other than blood.	740
	nonpathogenic or disabled bacteria or by creating genetically attenuated parasites (GAPs).	702	A-22		tometry and FACS analysis.	740
16-24	The route of vaccination is an important determinant	102	A-23	The state of the s	ocyte isolation using antibody-coated magnetic	
10 24	of success.	702		beads.		742
16-25	Bordetella pertussis vaccination illustrates the importance		A-24	Isolatio	n of homogeneous T-cell lines.	742
	of the perceived safety of a vaccine.	704	Char	octorizat	ion of lymphocyte specificity, frequency,	
16-26	Conjugate vaccines have been developed as a result of			unction.	ion of lymphocyte specificity, frequency,	743
	understanding how T and B cells collaborate in an immune response.	705	A-25		g-dilution culture.	744
16-27	Peptide-based vaccines can elicit protective immunity, but		A-26		OT assays.	745
	they require adjuvants and must be targeted to the appropriate cells and cell compartment to be effective.	705	A-27		cation of functional subsets of T cells by staining	746
16-28	Adjuvants are important for enhancing the immunogenicity of vaccines, but few are approved for use in humans.	707	A-28		cation of T-cell receptor specificity using peptide:MHC	746
16-29	Protective immunity can be induced by DNA-based		A-29		ing the diversity of the T-cell repertoire by	
	vaccination.	708		'spectra		748
16-30	The effectiveness of a vaccine can be enhanced by targeting it to sites of antigen presentation.	708	A-30	Biosens and dis	sor assays for measuring the rates of association association of antigen receptors for their ligands.	749
16-31	An important question is whether vaccination can be used therapeutically to control existing chronic infections.	709	A-31		tion of lymphocyte proliferation by treatment with nal mitogens or specific antigen.	750
Summa		710	A-32	Measur	ements of apoptosis by the TUNEL assay.	751
Summa	ary to Chapter 16.	711	A-33		for cytotoxic T cells.	751
Questio		711	A-34	Assays	for CD4 T cells.	751
	I references.	712	Dotoo	tion of i	mmunity in vivo	752
Section	references.	712			mmunity in vivo.	753
			A-35 A-36		ment of protective immunity. r of protective immunity.	753
			A30	Iransie	of brotective immunity.	753
Anne	ndix I The Immunologist's Toolbox	717				
av im	ndix I The Immunologist's Toolbox	717	A-37	The tub	erculin test.	754
av im	ndix I The Immunologist's Toolbox nization.	717 717	A-37 A-38	The tub Testing	erculin test. for allergic responses.	
av im	nization. Haptens.		A-37	The tub Testing Assessi	erculin test.	754
A-1 A-2	hization. Haptens. Routes of immunization.	717 718 720	A-37 A-38	The tub Testing Assessi compet	erculin test. for allergic responses. ment of immune responses and immunological	754 754
A-1 A-2 A-3	Haptens. Routes of immunization. Effects of antigen dose.	717 718 720 720	A-37 A-38 A-39	The tub Testing Assessi compete The Art	erculin test. for allergic responses. ment of immune responses and immunological ence in humans.	754 754 754
A-1 A-2	hization. Haptens. Routes of immunization.	717 718 720	A-37 A-38 A-39 A-40	The tub Testing Assessi compet The Art Adoptiv	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction.	754 754 754 756
Immur A-1 A-2 A-3 A-4	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants.	717 718 720 720	A-37 A-38 A-39 A-40 A-41	The tub Testing Assessi compete The Art Adoptive Hemato In vivo of	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells.	754 754 754 756 756
Immur A-1 A-2 A-3 A-4 The de	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. etection, measurement, and characterization	717 718 720 720	A-37 A-38 A-39 A-40 A-41 A-42	The tub Testing Assessi compete The Art Adoptive Hemato In vivo of In vivo of	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells.	754 754 756 756 757
Immur A-1 A-2 A-3 A-4 The de	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants.	717 718 720 720	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44 A-45	The tub Testing Assessi compete The Art Adoptiv Hemato In vivo o Transge	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice.	754 754 756 756 757 757 757 758
Immur A-1 A-2 A-3 A-4 The de	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. etection, measurement, and characterization bodies and their use as research and estic tools.	717 718 720 720 720	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44	The tub Testing Assessi compete The Art Adoptiv Hemato In vivo o Transge	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells.	754 754 756 756 757 757 757
Immur A-1 A-2 A-3 A-4 The de	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. etection, measurement, and characterization bodies and their use as research and estic tools. Affinity chromatography.	717 718 720 720 720	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44 A-45	The tub Testing Assessi compete The Art Adoptiv Hemato In vivo o Transge	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice.	754 754 756 756 757 757 757 758
A-1 A-2 A-3 A-4 The de diagno	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. etection, measurement, and characterization bodies and their use as research and estic tools.	717 718 720 720 720	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44 A-45 A-46	The tub Testing Assess compete The Art Adoptiv Hemato In vivo o Transge Gene ki	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption.	754 754 756 756 757 757 757 758 759
A-1 A-2 A-3 A-4 The de diagno	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. etection, measurement, and characterization bodies and their use as research and estic tools. Affinity chromatography. Radioimmunoassay (TuA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing.	717 718 720 720 723 723 723 723 724	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44 A-45 A-46 A-46	The tub Testing Assess compete The Art Adoptiv Hemato In vivo of Transge Gene kinds ndix II	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. poickout by targeted disruption.	754 754 756 756 757 757 757 758 759
Immur A-1 A-2 A-3 A-4 The de diagno A-5 A-6	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. etection, measurement, and characterization bodies and their use as research and estic tools. Affinity chromatography. Radioimmunoassay (TuA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction.	717 718 720 720 723 723 723	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44 A-45 A-46 A-46	The tub Testing Assess compete The Art Adoptiv Hemato In vivo of Transge Gene kinds ndix II	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption.	754 754 756 756 757 757 757 758 759
Immur A-1 A-2 A-3 A-4 The de diagno A-5 A-6	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Etection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TIA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity.	717 718 720 720 723 723 723 723 724	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44 A-45 A-46 Appe Appe	The tub Testing Assess compete The Art Adoptiv Hemato In vivo o Transge Gene ki ndix II ndix III	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. poickout by targeted disruption.	754 754 756 756 757 757 757 758 759
A-7 A-8	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Etection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TIA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies.	717 718 720 720 723 723 723 724 725 727 727	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-45 A-46 Appe Appe Appe Appe	The tub Testing Assess compete The Art Adoptiv Hemato In vivo o Transge Gene ki ndix II ndix III	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption. CD Antigens Cytokines and Their Receptors	754 754 756 756 757 757 757 758 759 763 779
A-3 A-4 The de diagno A-5 A-6 A-8 A-9	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Etection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TuA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies. Coombs tests and the detection of Rhesus incompatibility.	717 718 720 720 723 723 723 724 725 727 727 729	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-45 A-46 Appe Appe Biogr	The tub Testing Assess compete The Art Adoptive Hemato In vivo of Transge Gene kin ndix II ndix III ndix IV aphies	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption. CD Antigens Cytokines and Their Receptors Chemokines and Their Receptors	754 754 756 757 757 757 758 759 763 779 782 784
Immur A-1 A-2 A-3 A-4 The de of anti- diagno A-5 A-6 A-7 A-8 A-9 A-10 A-11 A-12	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Etection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TuA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies. Coombs tests and the detection of Rhesus incompatibility. Monoclonal antibodies.	717 718 720 720 723 723 723 724 725 727 729 730	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44 A-45 A-46 Appe Appe Appe Biogr Photo	The tub Testing Assess compete The Art Adoptive Hemato In vivo of Transge Gene kill Indix III Indix IV Taphies Ograph	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption. CD Antigens Cytokines and Their Receptors	754 754 756 757 757 757 758 759 763 779 782 784 785
A-10 A-10 A-10 A-10 A-10 A-10 A-10 A-10	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Adjuvants. Adjuvants. Affinity chromatography. Radioimmunoassay (FuA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies. Coombs tests and the detection of Rhesus incompatibility. Monoclonal antibodies. Phage display libraries for antibody V-region production.	717 718 720 720 723 723 723 724 725 727 729 730 731	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-45 A-46 Appe Appe Biogr	The tub Testing Assess compete The Art Adoptive Hemato In vivo of Transge Gene kill Indix III Indix IV Taphies Ograph	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption. CD Antigens Cytokines and Their Receptors Chemokines and Their Receptors	754 754 756 757 757 757 758 759 763 779 782 784
Immur A-1 A-2 A-3 A-4 The de of anti- diagno A-5 A-6 A-10 A-10 A-12 A-13 A-14	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Petection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TuA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies. Coombs tests and the detection of Rhesus incompatibility. Monoclonal antibodies. Phage display libraries for antibody V-region production. Microscopy and imaging.	717 718 720 720 720 723 723 723 724 725 727 729 730 731 732	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-44 A-45 A-46 Appe Appe Appe Biogr Photo	The tub Testing Assess compete The Art Adoptive Hemato In vivo of Transge Gene kill Indix III Indix IV Taphies Ograph Sary	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption. CD Antigens Cytokines and Their Receptors Chemokines and Their Receptors	754 754 756 757 757 757 758 759 763 779 782 784 785
Immur A-1 A-2 A-3 A-4 The de of anti diagno A-5 A-6 A-10 A-10 A-10 A-12 A-13 A-14 A-15	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Petection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TuA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies. Coombs tests and the detection of Rhesus incompatibility. Monoclonal antibodies. Phage display libraries for antibody V-region production. Microscopy and imaging. Immunoelectron microscopy.	717 718 720 720 720 723 723 723 724 725 727 729 730 731 732 734	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-45 A-46 Appe Appe Appe Biogr Photo Gloss	The tub Testing Assess compete The Art Adoptive Hemato In vivo of Transge Gene kill Indix III Indix IV Taphies Ograph Sary	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption. CD Antigens Cytokines and Their Receptors Chemokines and Their Receptors	754 754 756 757 757 757 758 759 763 779 782 784 785 786
Immur A-1 A-2 A-3 A-4 The de of anti- diagno A-5 A-6 A-10 A-10 A-12 A-13 A-14	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Etection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TIA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies. Coombs tests and the detection of Rhesus incompatibility. Monoclonal antibodies. Phage display libraries for antibody V-region production. Microscopy and imaging. Immunoelectron microscopy. Immunohistochemistry.	717 718 720 720 720 723 723 723 724 725 727 729 730 731 732 734 735	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-45 A-46 Appe Appe Appe Biogr Photo Gloss	The tub Testing Assess compete The Art Adoptive Hemato In vivo of Transge Gene kill Indix III Indix IV Taphies Ograph Sary	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption. CD Antigens Cytokines and Their Receptors Chemokines and Their Receptors	754 754 756 757 757 757 758 759 763 779 782 784 785 786
Immur A-1 A-2 A-3 A-4 The de of anti- diagno A-5 A-6 A-10 A-11 A-12 A-13 A-14 A-15 A-16 A-17	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Etection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TuA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies. Coombs tests and the detection of Rhesus incompatibility. Monoclonal antibodies. Phage display libraries for antibody V-region production. Microscopy and imaging. Immunoelectron microscopy. Immunohistochemistry. Immunoprecipitation and co-immunoprecipitation.	717 718 720 720 720 723 723 723 724 725 727 729 730 731 732 734 735 735	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-45 A-46 Appe Appe Appe Biogr Photo Gloss	The tub Testing Assess compete The Art Adoptive Hemato In vivo of Transge Gene kill Indix III Indix IV Taphies Ograph Sary	for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. inic mice. hockout by targeted disruption. CD Antigens Cytokines and Their Receptors Chemokines and Their Receptors Acknowledgments	754 754 756 757 757 757 758 759 763 779 782 784 785 786 823
Immur A-1 A-2 A-3 A-4 The de of anti diagno A-5 A-6 A-10 A-10 A-10 A-12 A-13 A-14 A-15	Haptens. Routes of immunization. Effects of antigen dose. Adjuvants. Etection, measurement, and characterization bodies and their use as research and ostic tools. Affinity chromatography. Radioimmunoassay (TIA), enzyme-linked immunosorbent assay (ELISA), and competitive inhibition assay. Hemagglutination and blood typing. Precipitin reaction. Equilibrium dialysis: measurement of antibody affinity and avidity. Anti-immunoglobulin antibodies. Coombs tests and the detection of Rhesus incompatibility. Monoclonal antibodies. Phage display libraries for antibody V-region production. Microscopy and imaging. Immunoelectron microscopy. Immunohistochemistry.	717 718 720 720 720 723 723 723 723 724 725 727 729 730 731 732 734 735 735 737	A-37 A-38 A-39 A-40 A-41 A-42 A-43 A-45 A-46 Appe Appe Biogr Photo Gloss Index	The tub Testing Assessicompet The Art Adoptive Hemato In vivo of Transge Gene kin ndix III ndix IV aphies ograph sary	erculin test. for allergic responses. ment of immune responses and immunological ence in humans. hus reaction. e transfer of lymphocytes. poietic stem-cell transfers. depletion of T cells. depletion of B cells. nic mice. nockout by targeted disruption. CD Antigens Cytokines and Their Receptors Chemokines and Their Receptors	754 754 756 757 757 757 758 759 763 779 782 784 785 786 823