

Peter Parham

The Immune System

Second Edition

Chapter 3

Antigen Recognition by T Lymphocytes

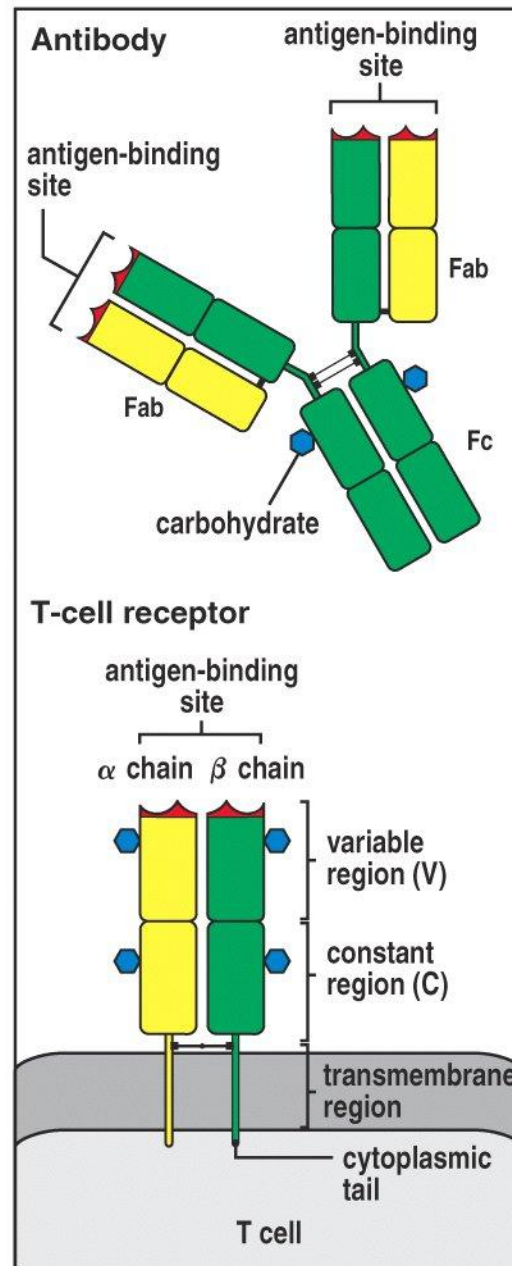


Figure 3-1 The Immune System, 2/e (© Garland Science 2005)

Antibody

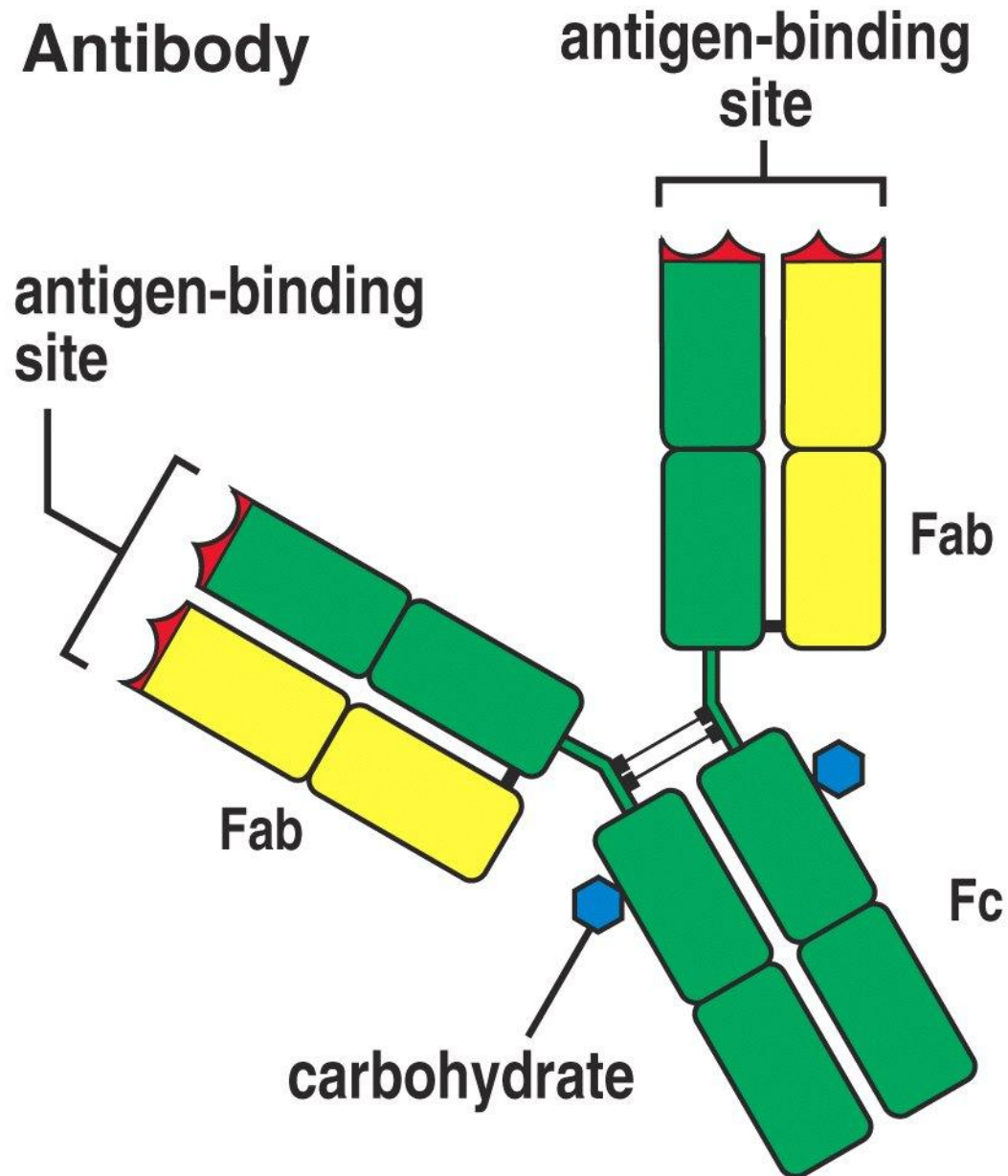


Figure 3-1 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

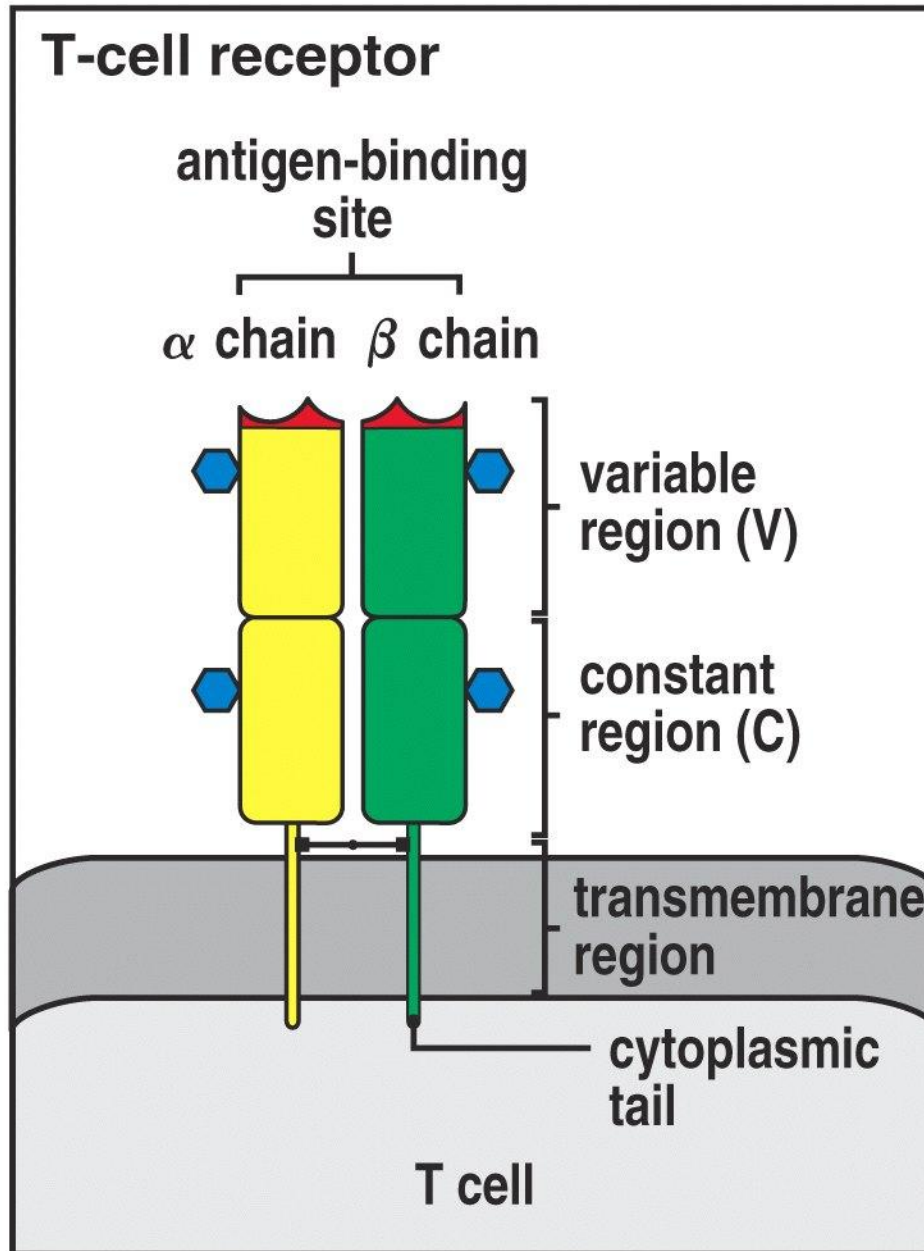


Figure 3-1 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

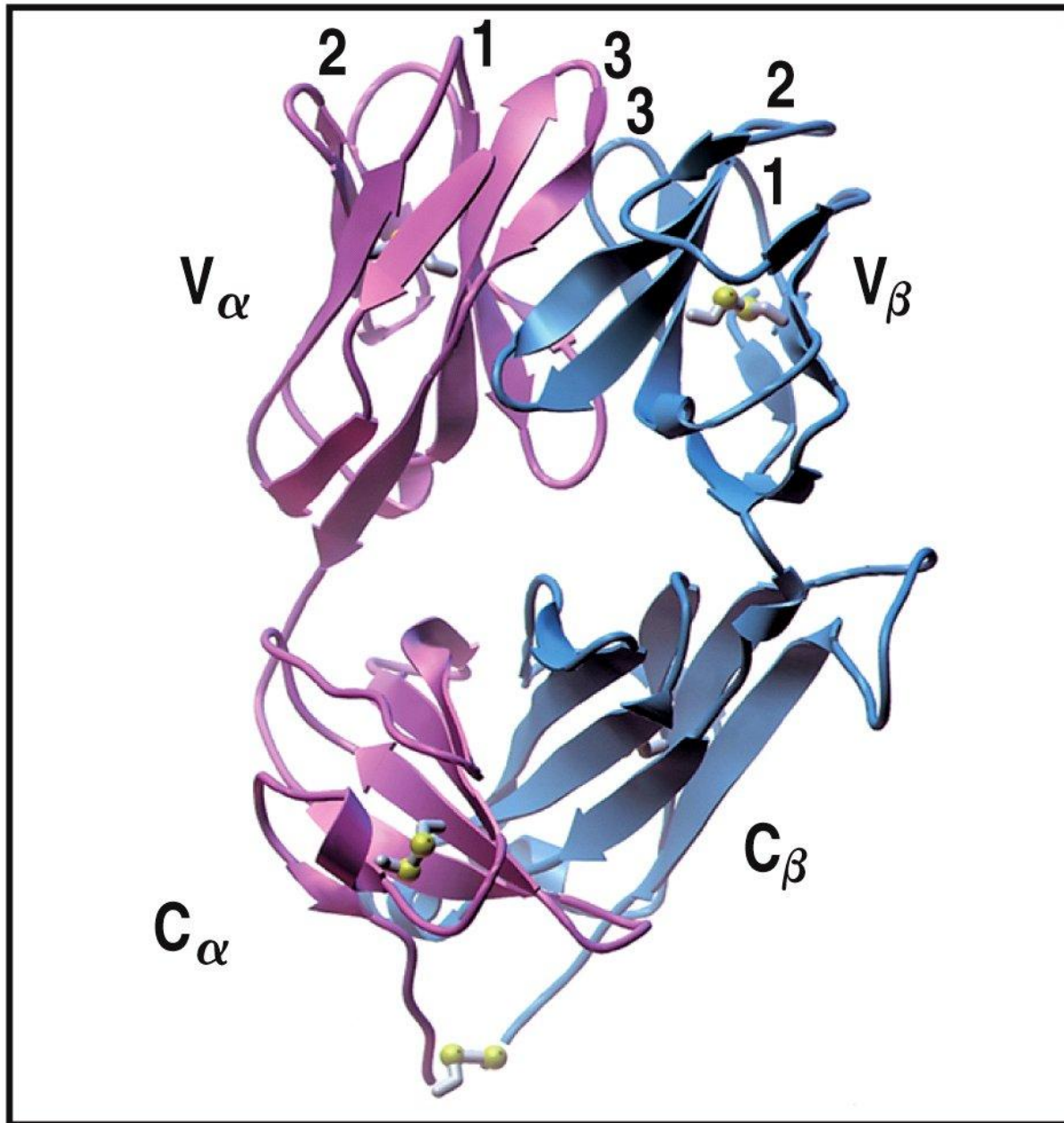


Figure 3-2 The Immune System, 2/e (© Garland Science 2005)

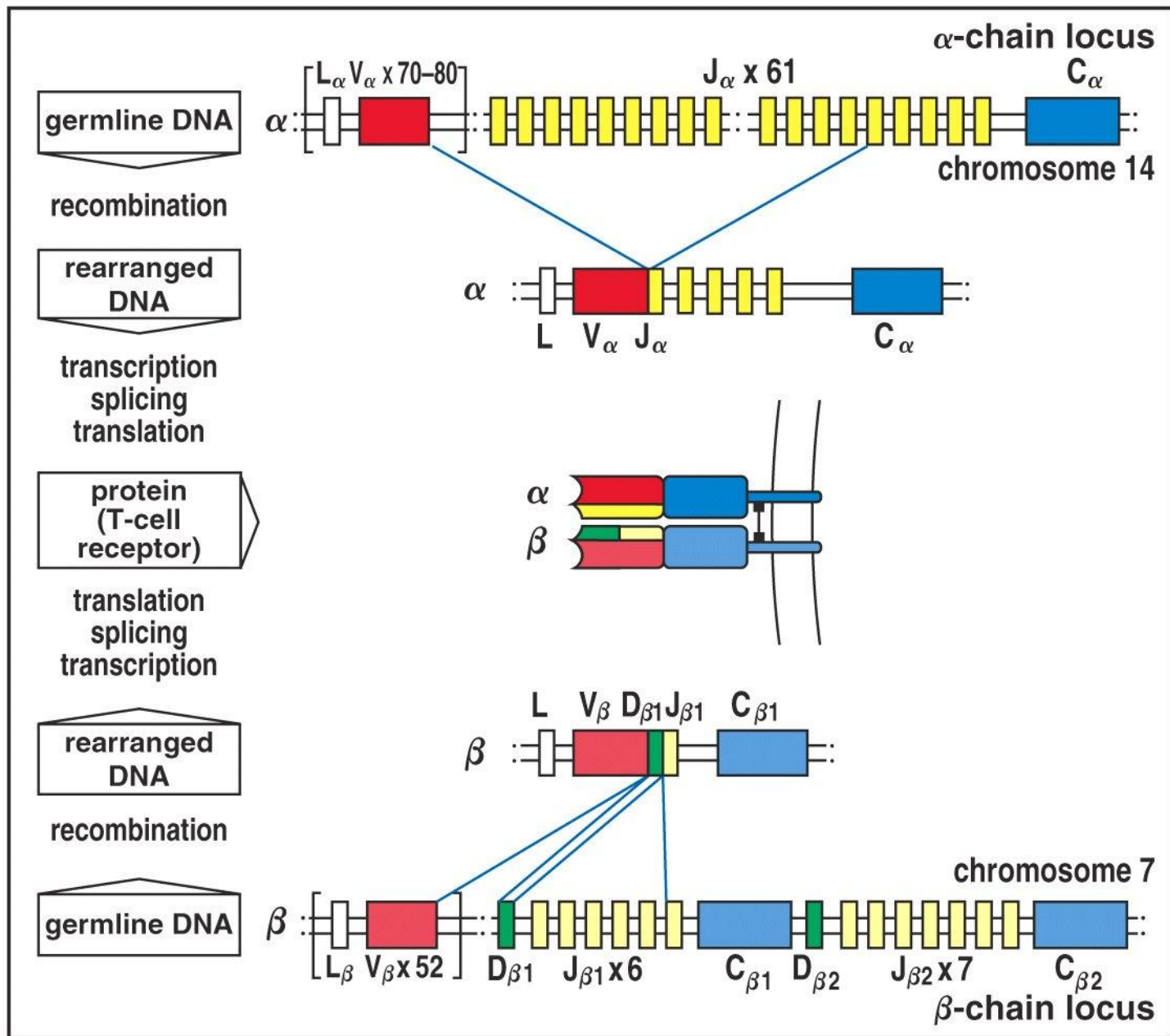


Figure 3-3 The Immune System, 2/e (© Garland Science 2005)

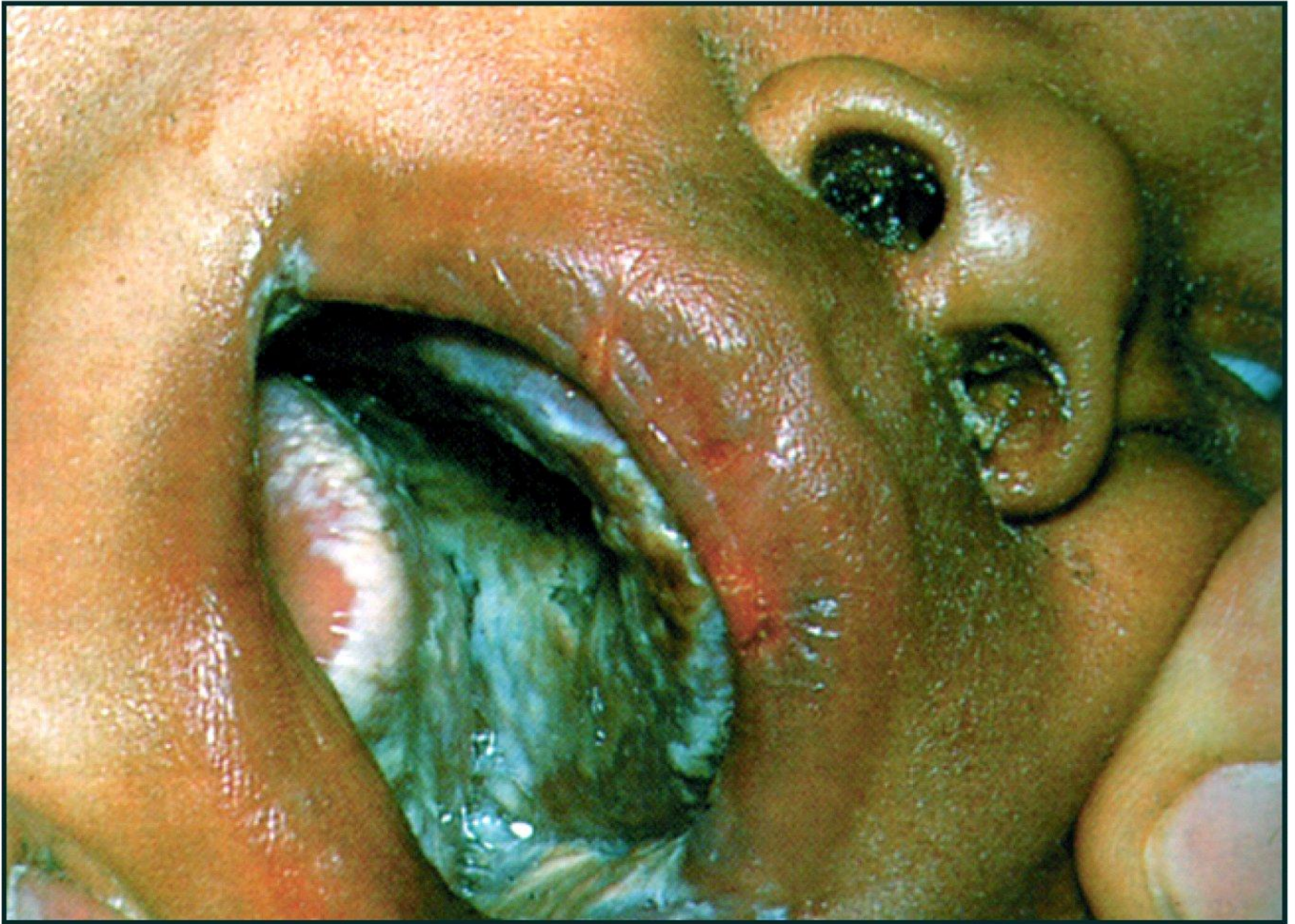


Figure 3-4 The Immune System, 2/e (© Garland Science 2005)



Figure 3-5 The Immune System, 2/e (© Garland Science 2005)

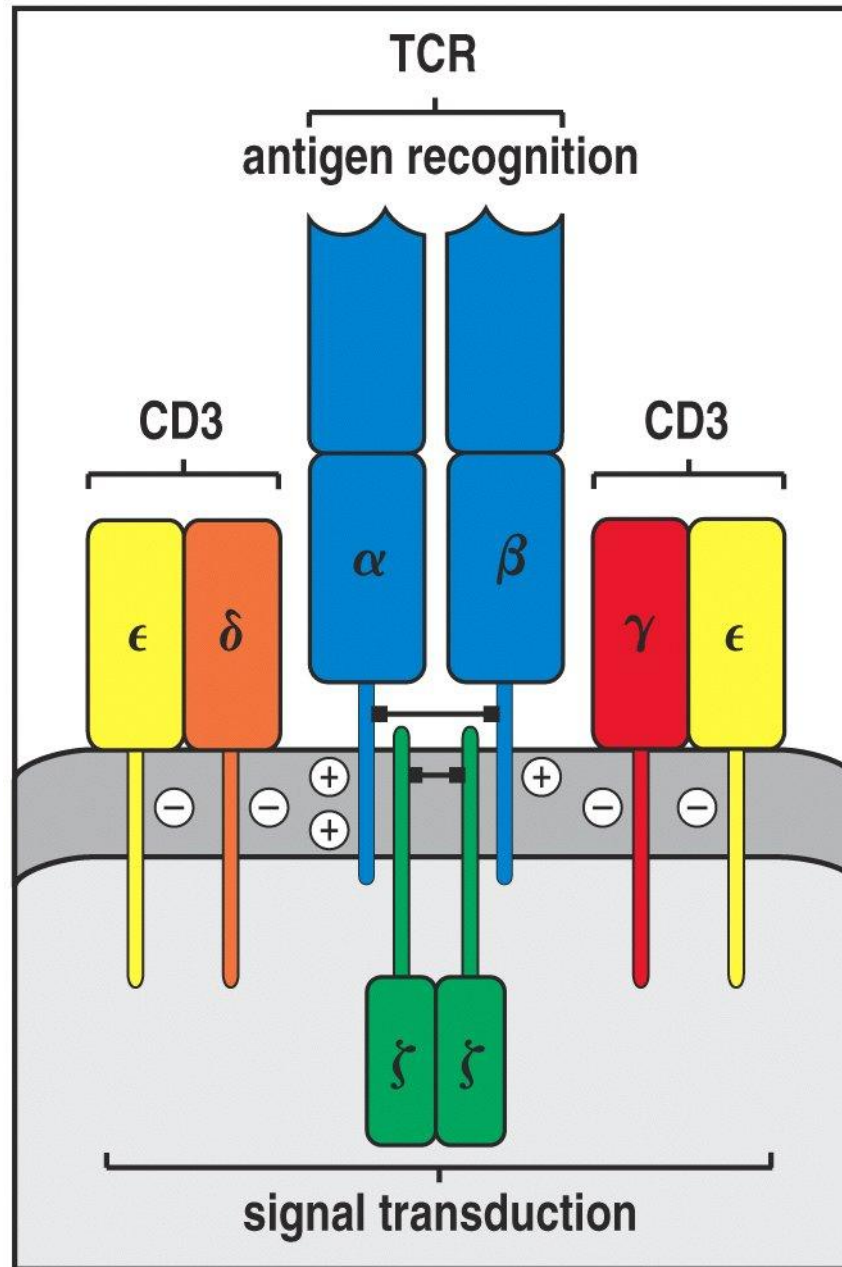


Figure 3-6 The Immune System, 2/e (© Garland Science 2005)

Two classes of T-cell receptor

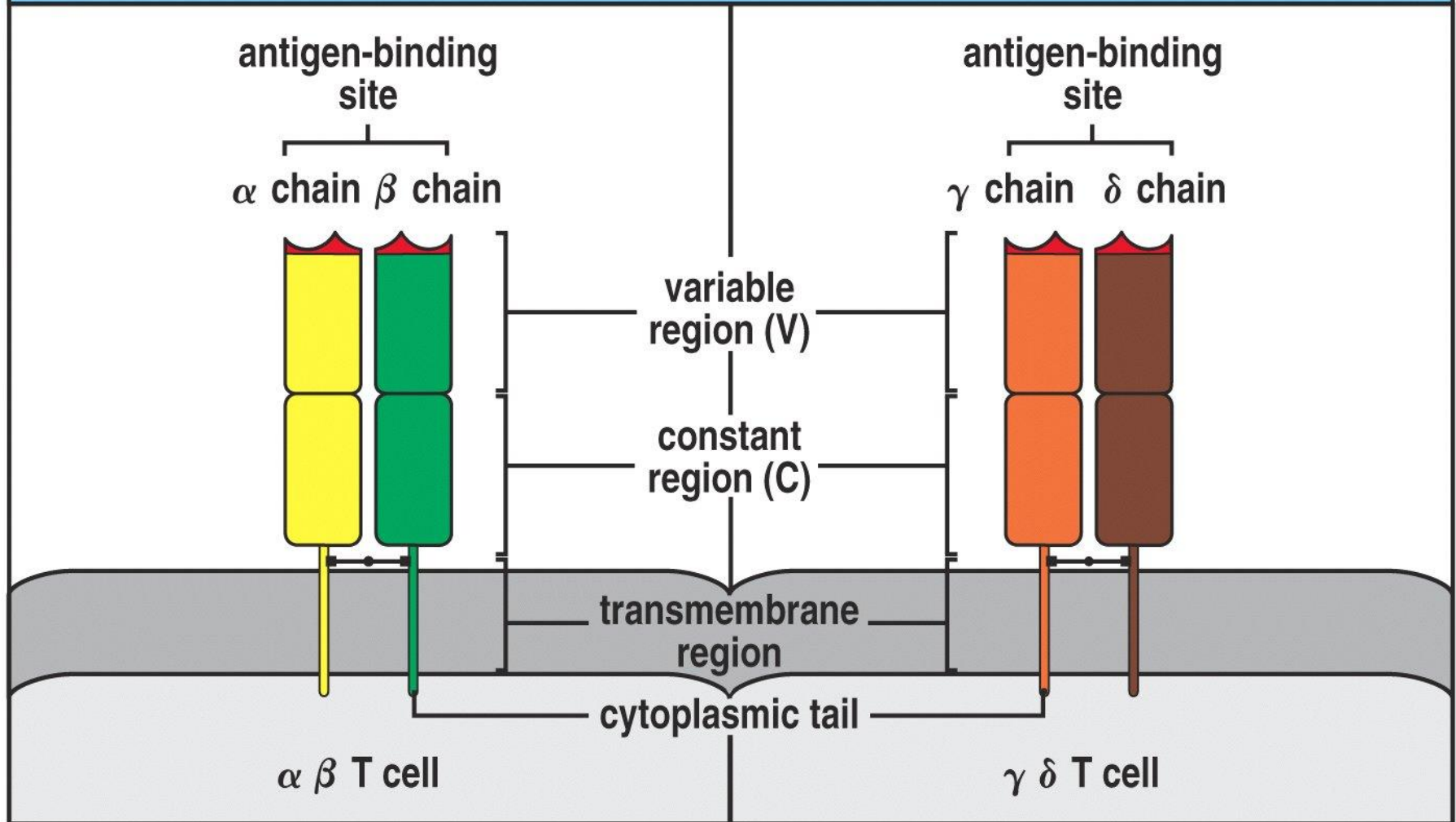
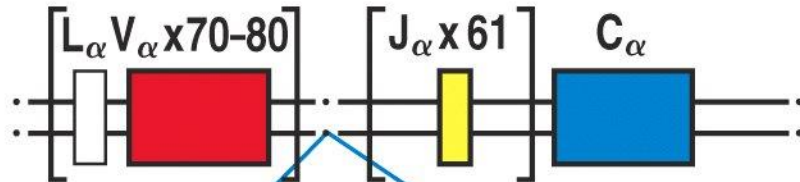


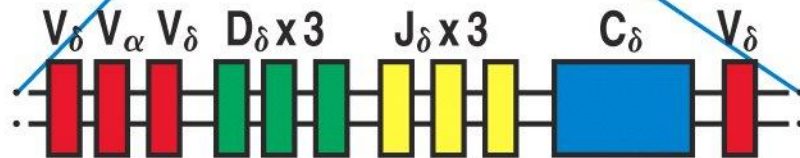
Figure 3-7 The Immune System, 2/e (© Garland Science 2005)

chromosome 14

α -chain locus



δ -chain locus



chromosome 7

γ -chain locus

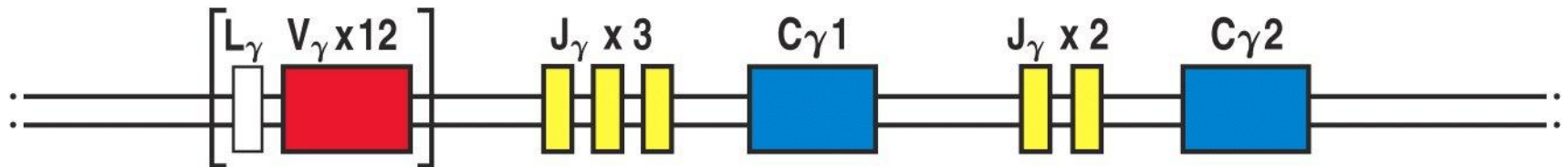
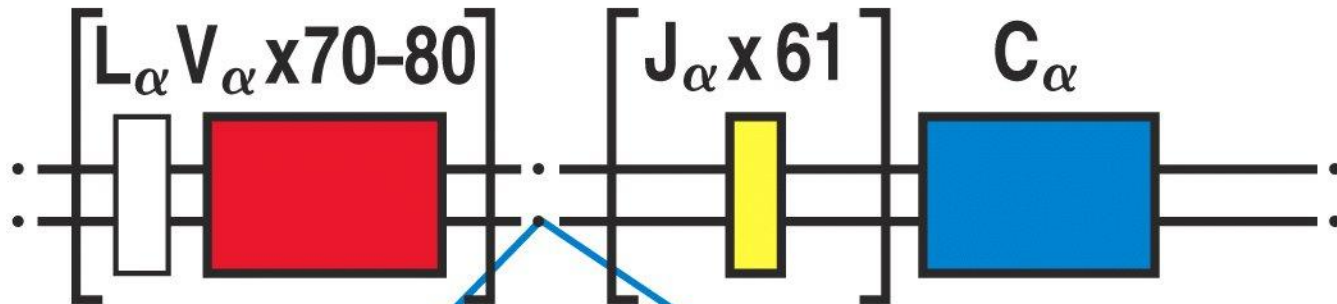


Figure 3-8 The Immune System, 2/e (© Garland Science 2005)

chromosome 14

α -chain locus



δ -chain locus

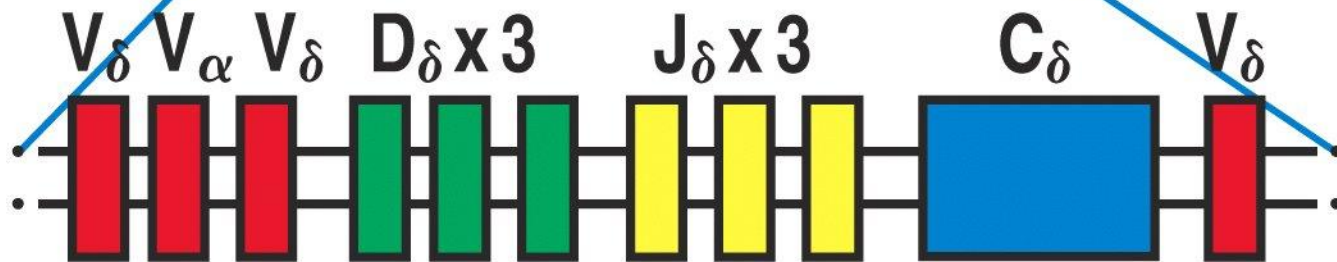


Figure 3-8 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

chromosome 7

γ -chain locus

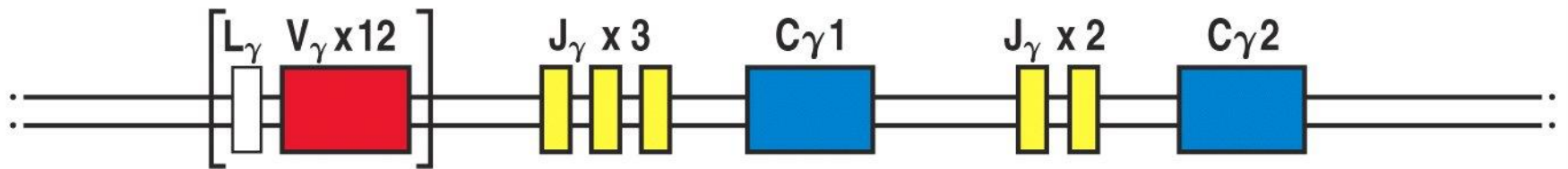


Figure 3-8 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

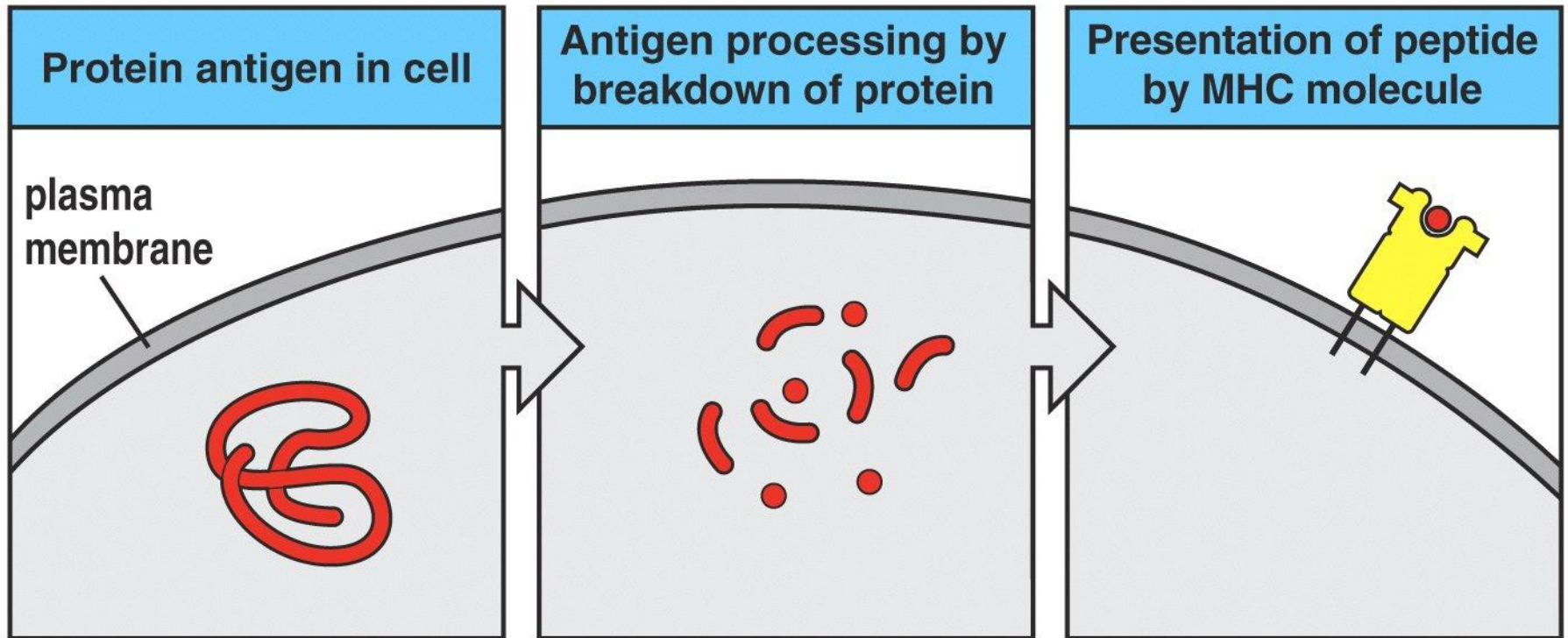


Figure 3-9 The Immune System, 2/e (© Garland Science 2005)

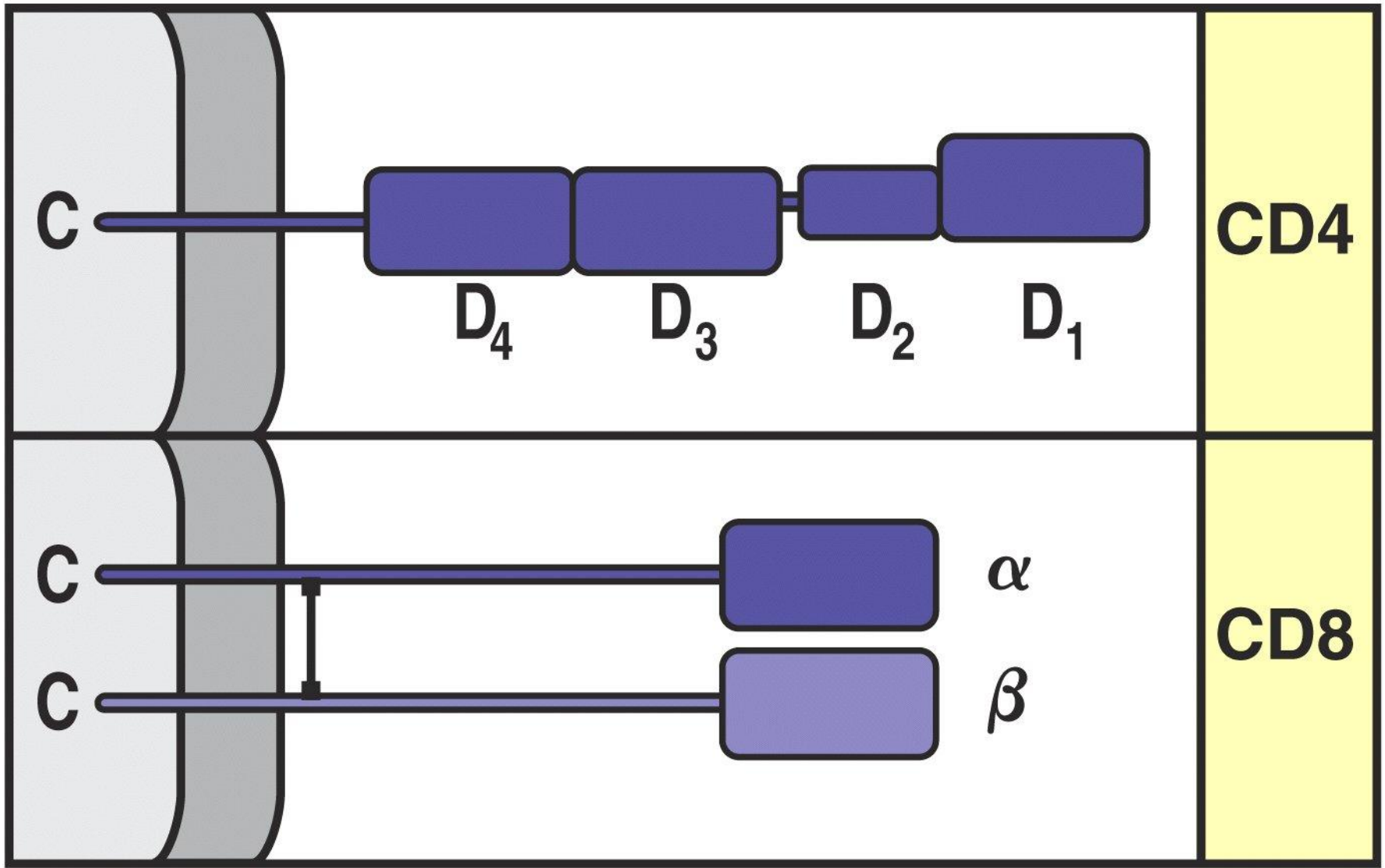


Figure 3-10 The Immune System, 2/e (© Garland Science 2005)

T cells function by making contact with other cells and inducing them to change

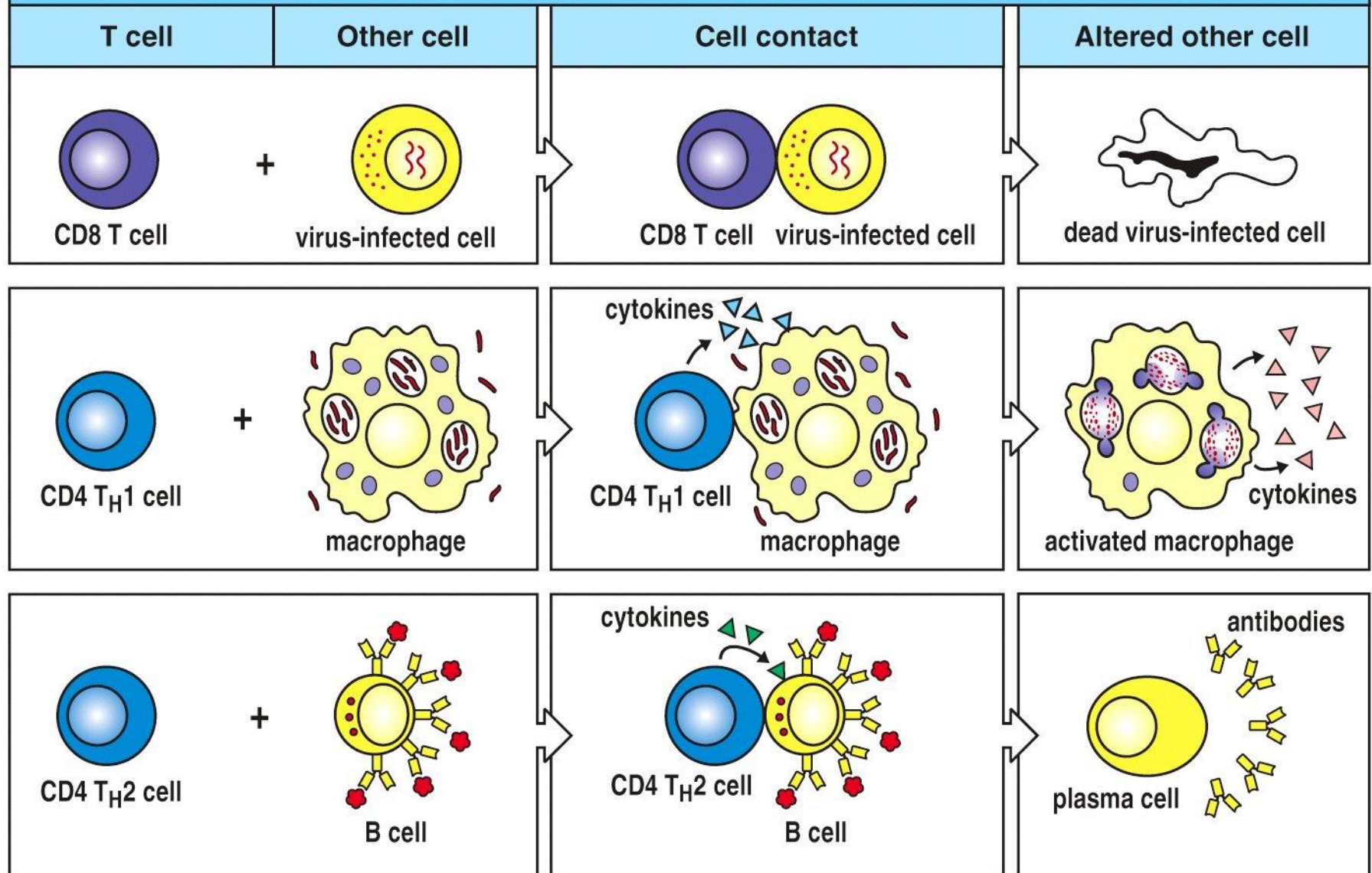


Figure 3-11 The Immune System, 2/e (© Garland Science 2005)

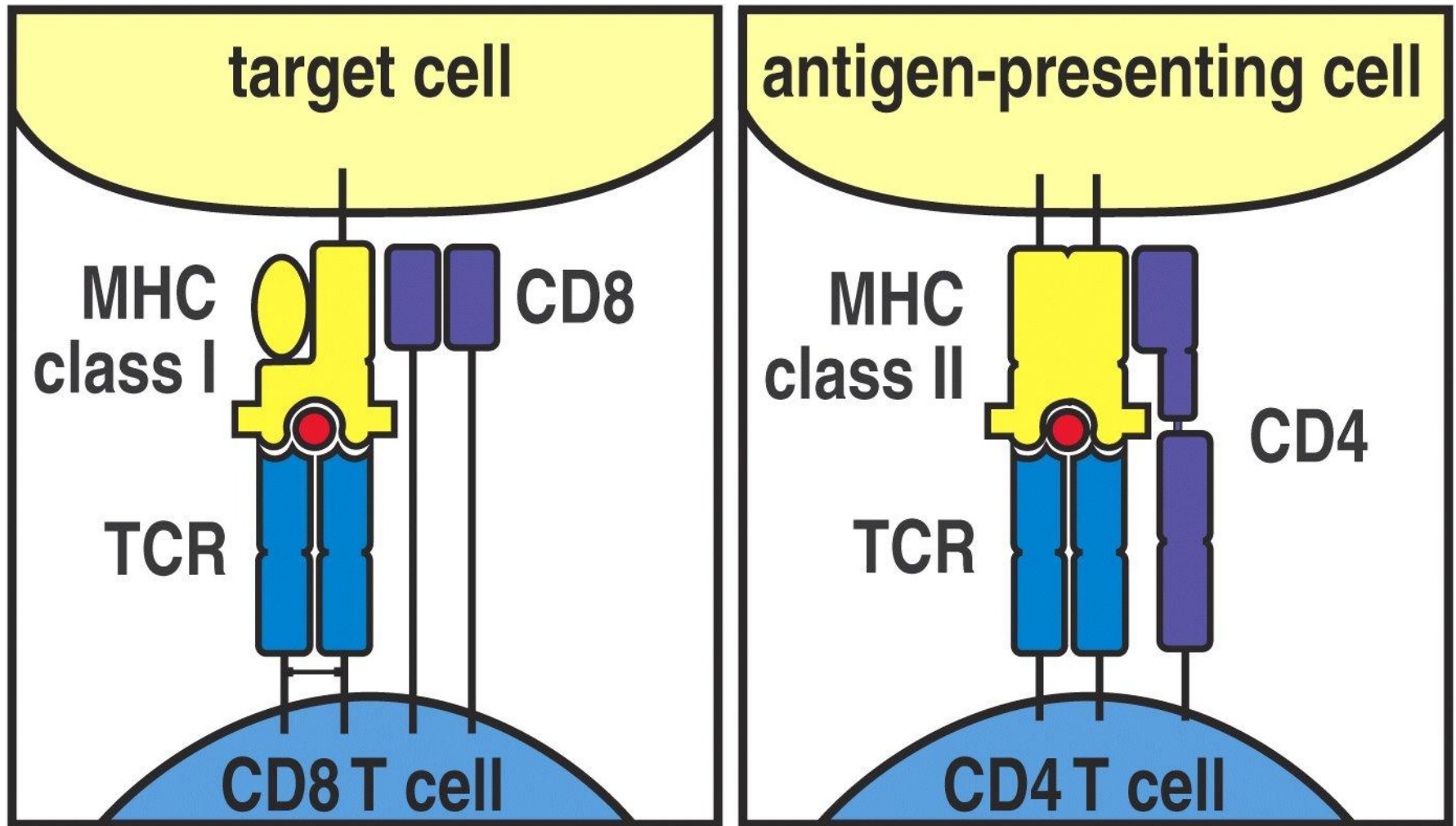


Figure 3-12 The Immune System, 2/e (© Garland Science 2005)

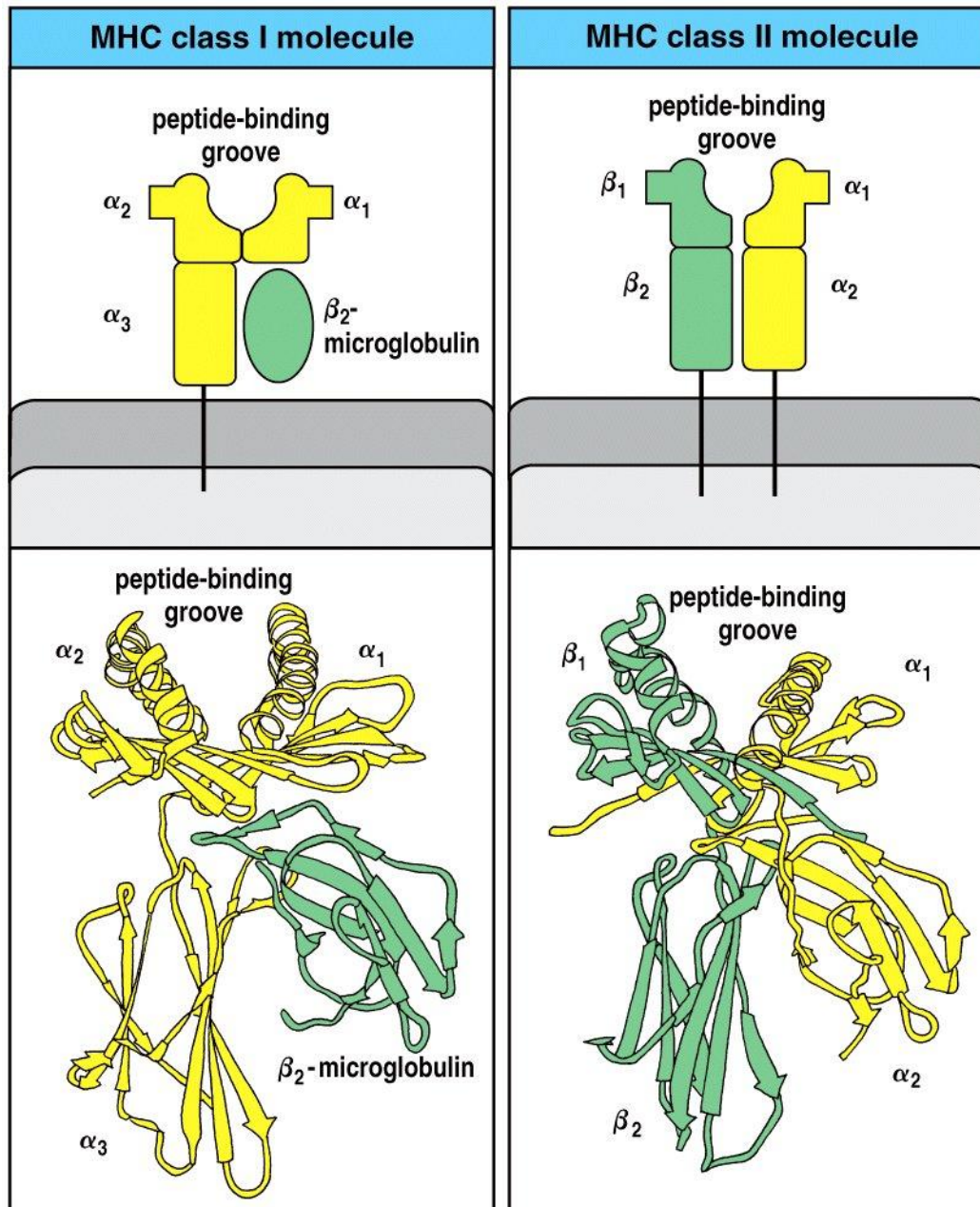
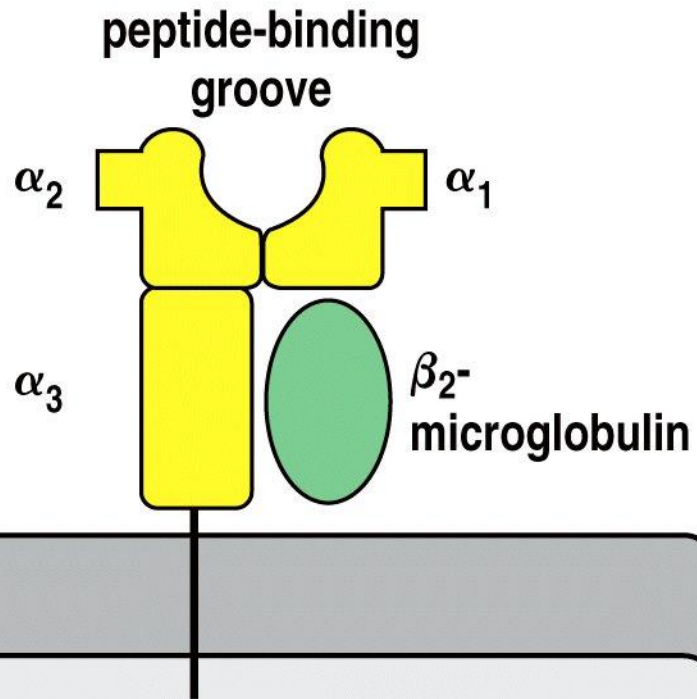


Figure 3-13 The Immune System, 2/e (© Garland Science 2005)

MHC class I molecule



MHC class II molecule

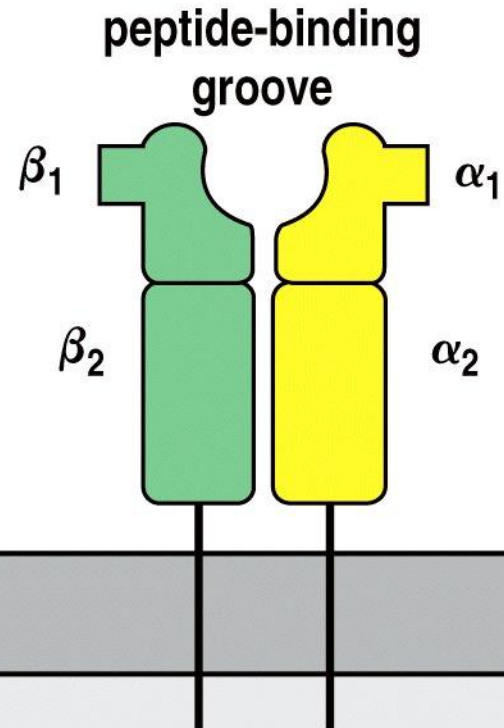
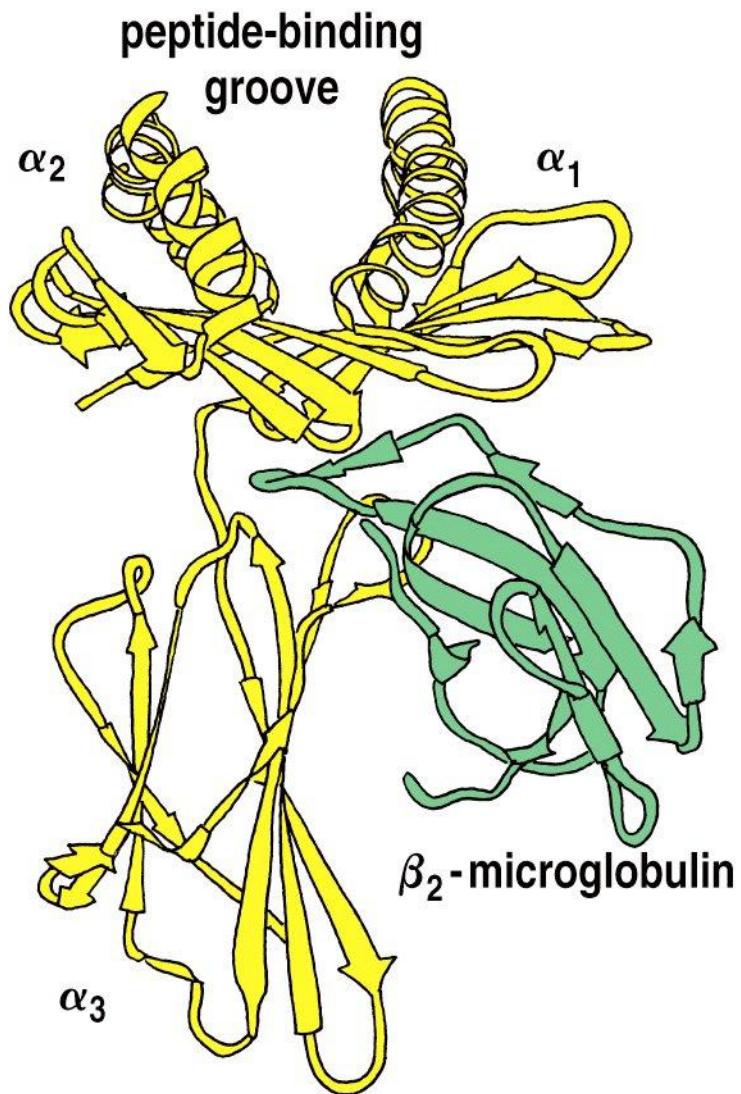
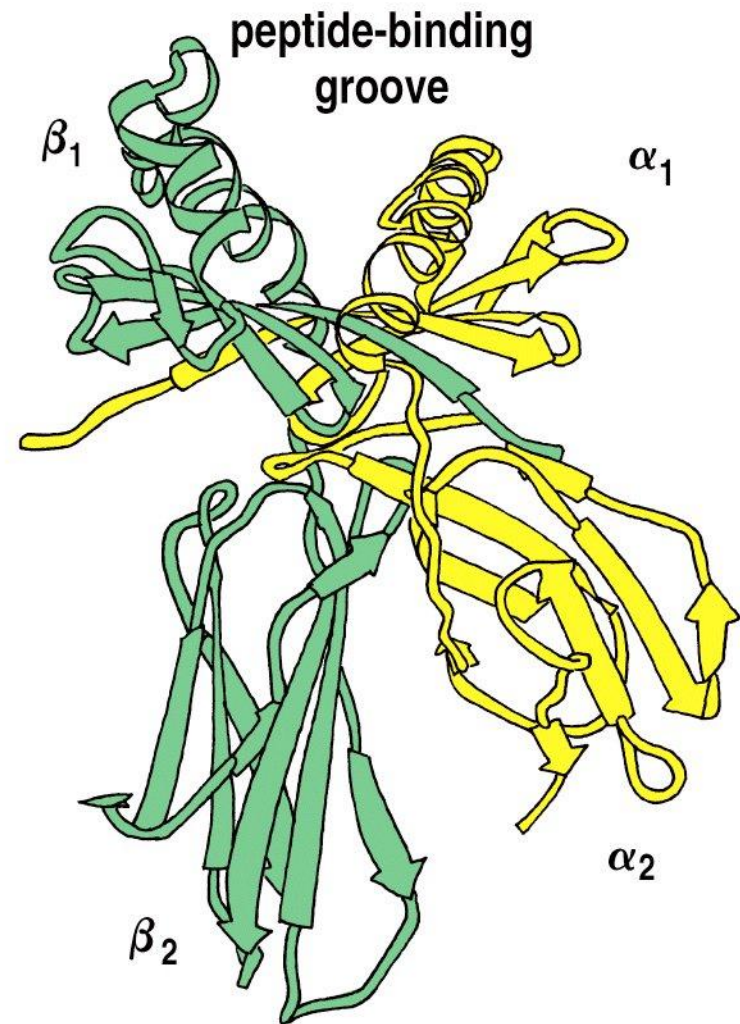


Figure 3-13 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

MHC class I molecule



MHC class II molecule



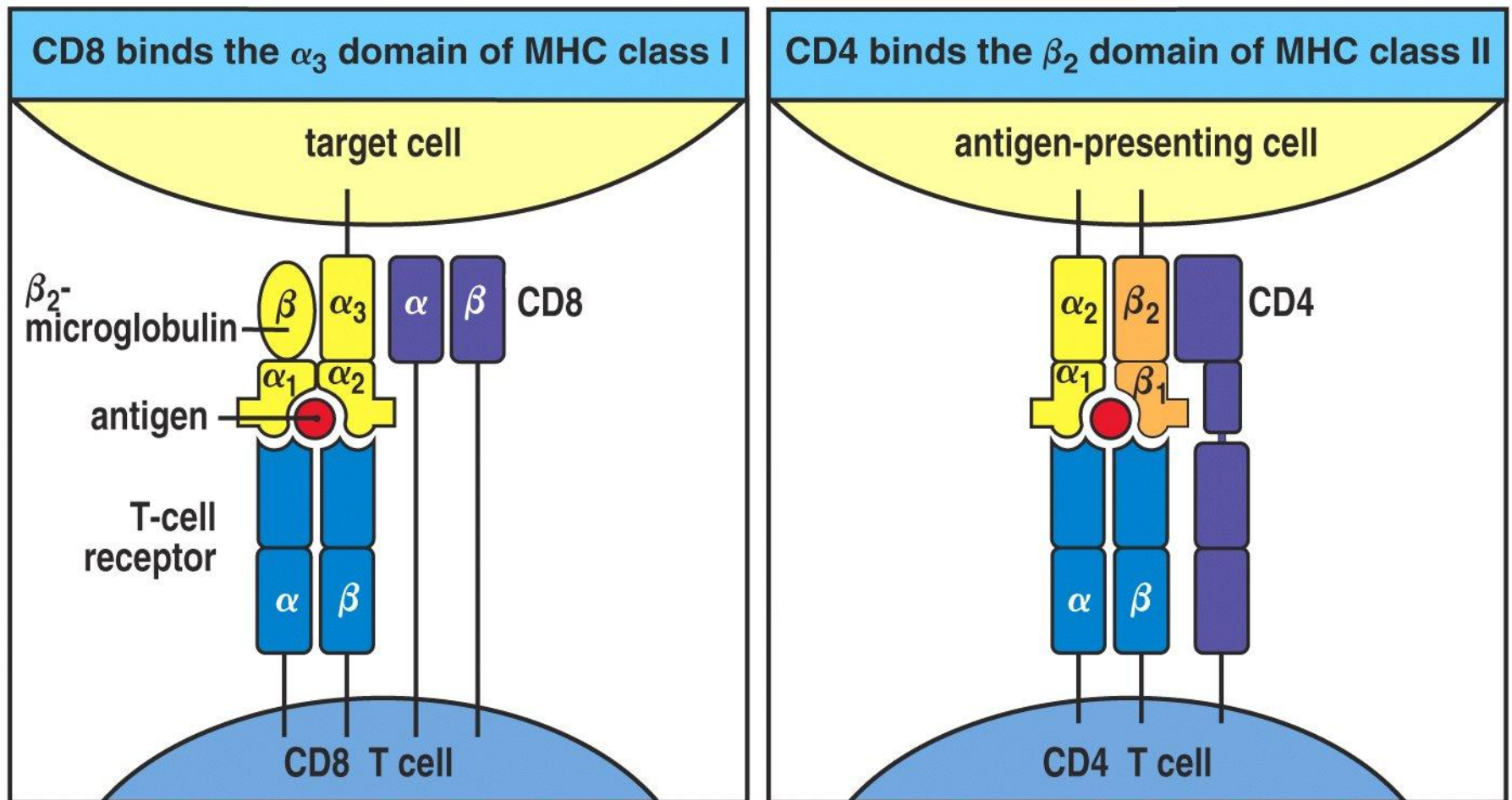
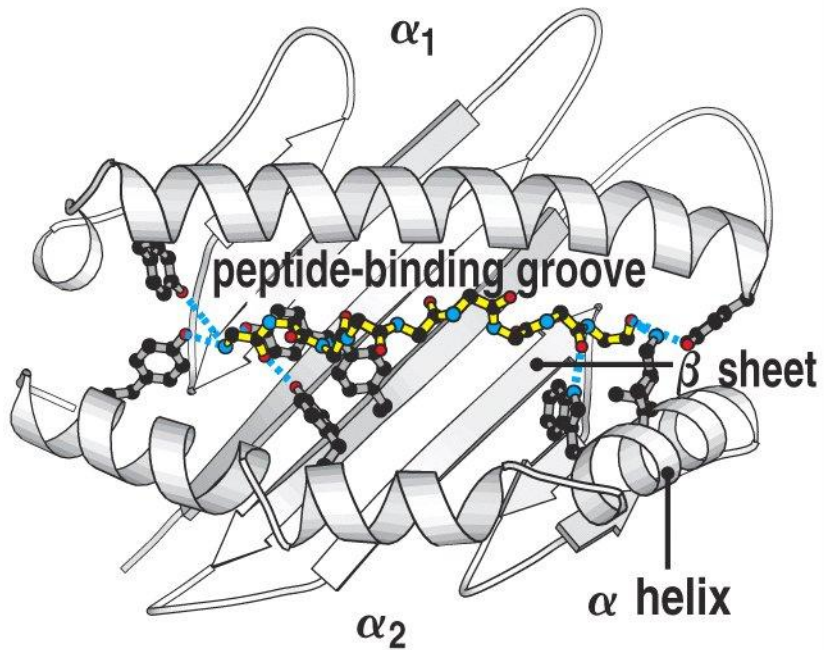


Figure 3-14 The Immune System, 2/e (© Garland Science 2005)

MHC class I



MHC class II

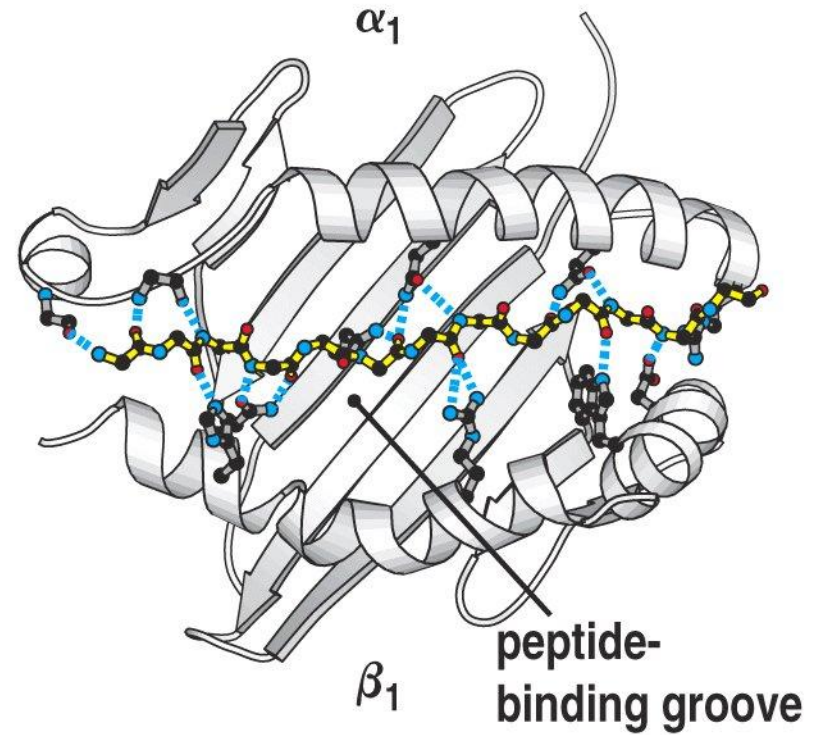


Figure 3-15 The Immune System, 2/e (© Garland Science 2005)

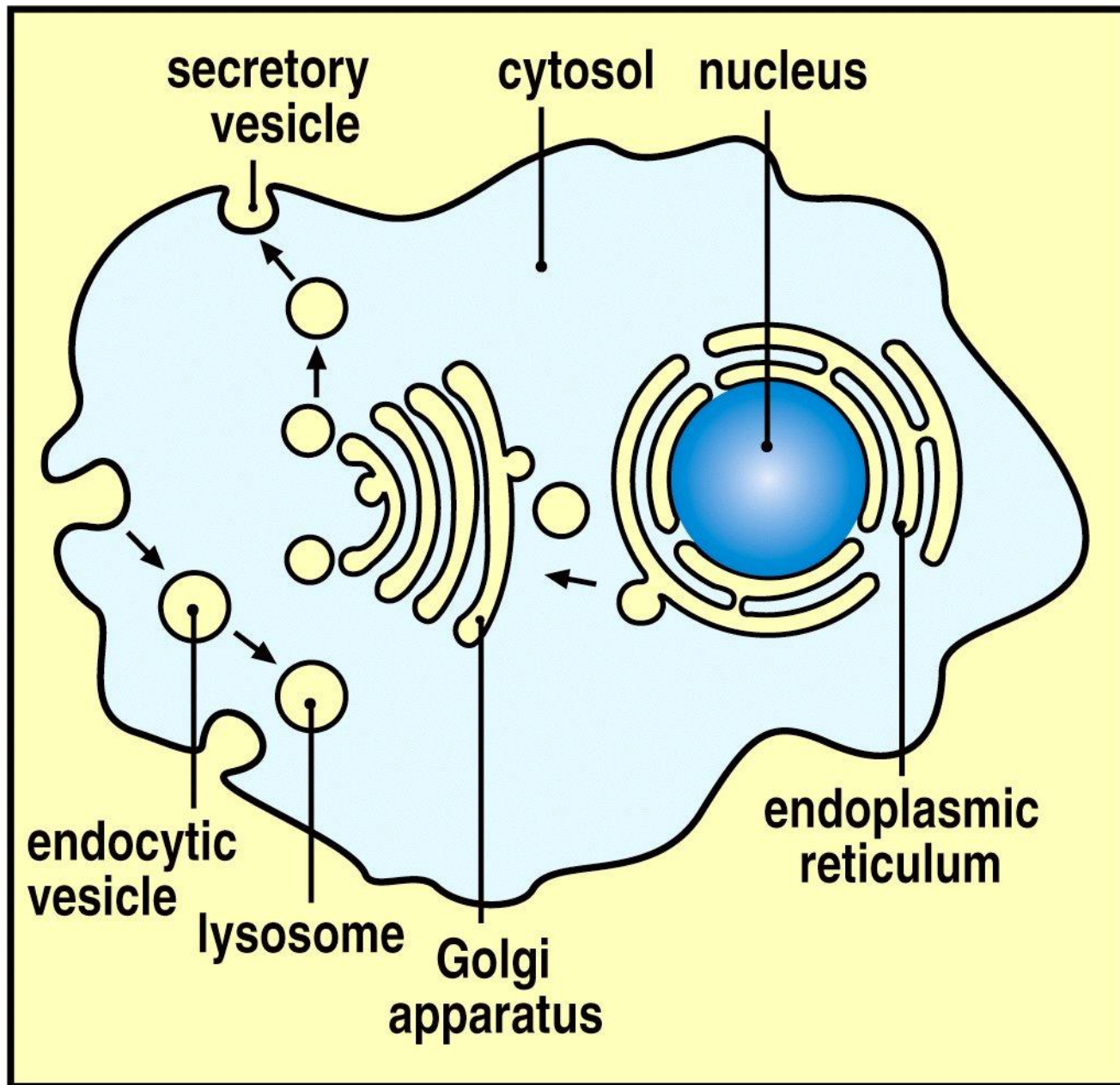


Figure 3-16 The Immune System, 2/e (© Garland Science 2005)

**Peptides produced in the
cytosol are transported into the
endoplasmic reticulum**

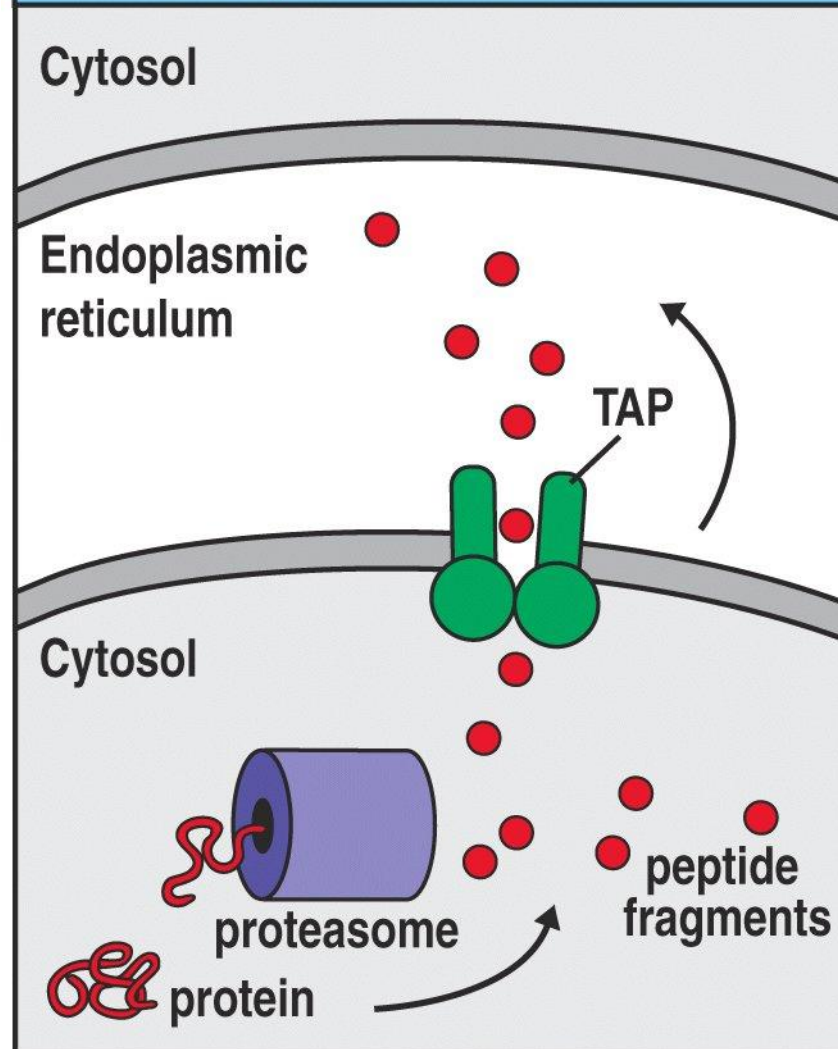


Figure 3-17 The Immune System, 2/e (© Garland Science 2005)

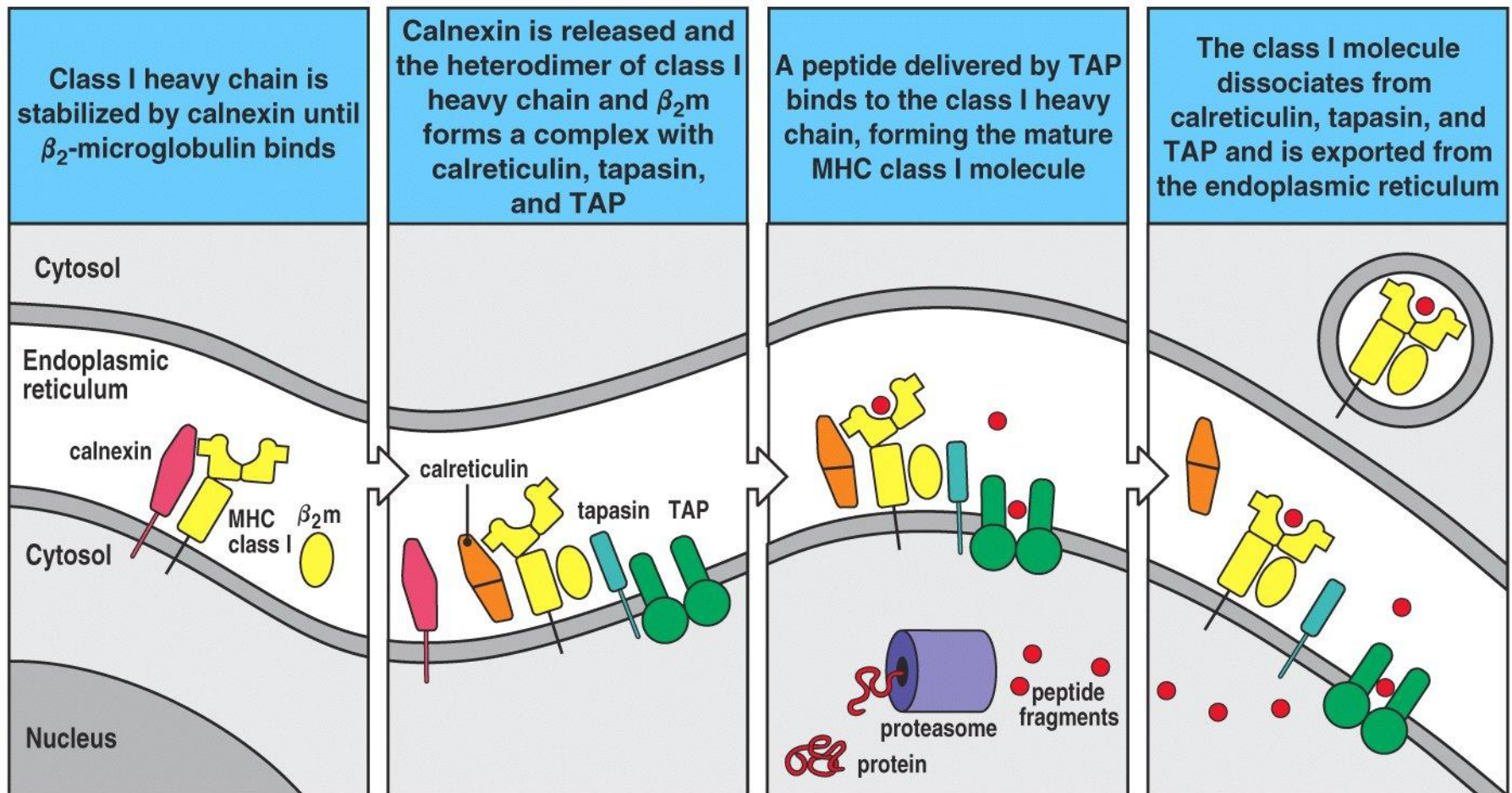


Figure 3-18 The Immune System, 2/e (© Garland Science 2005)

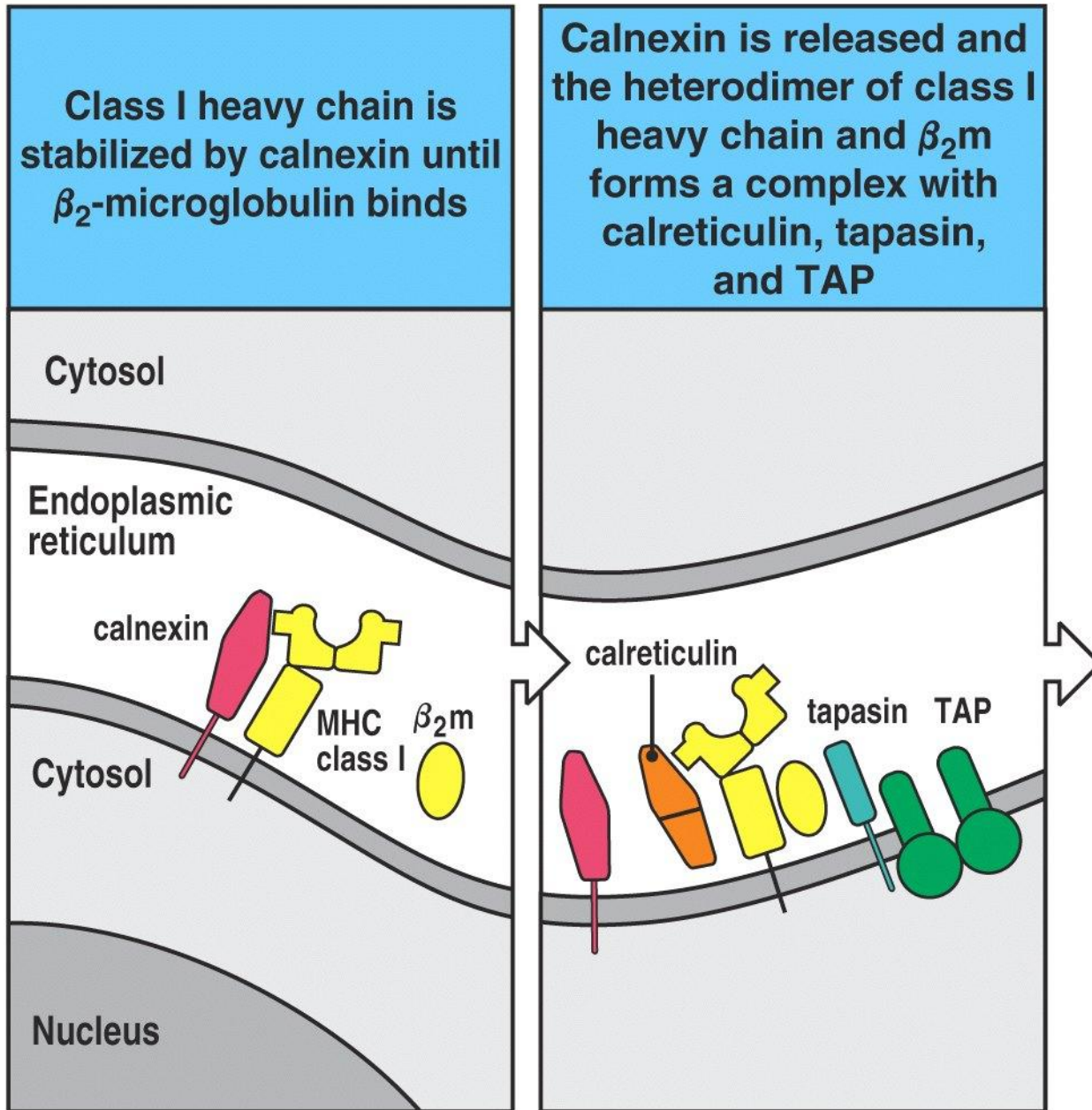


Figure 3-18 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

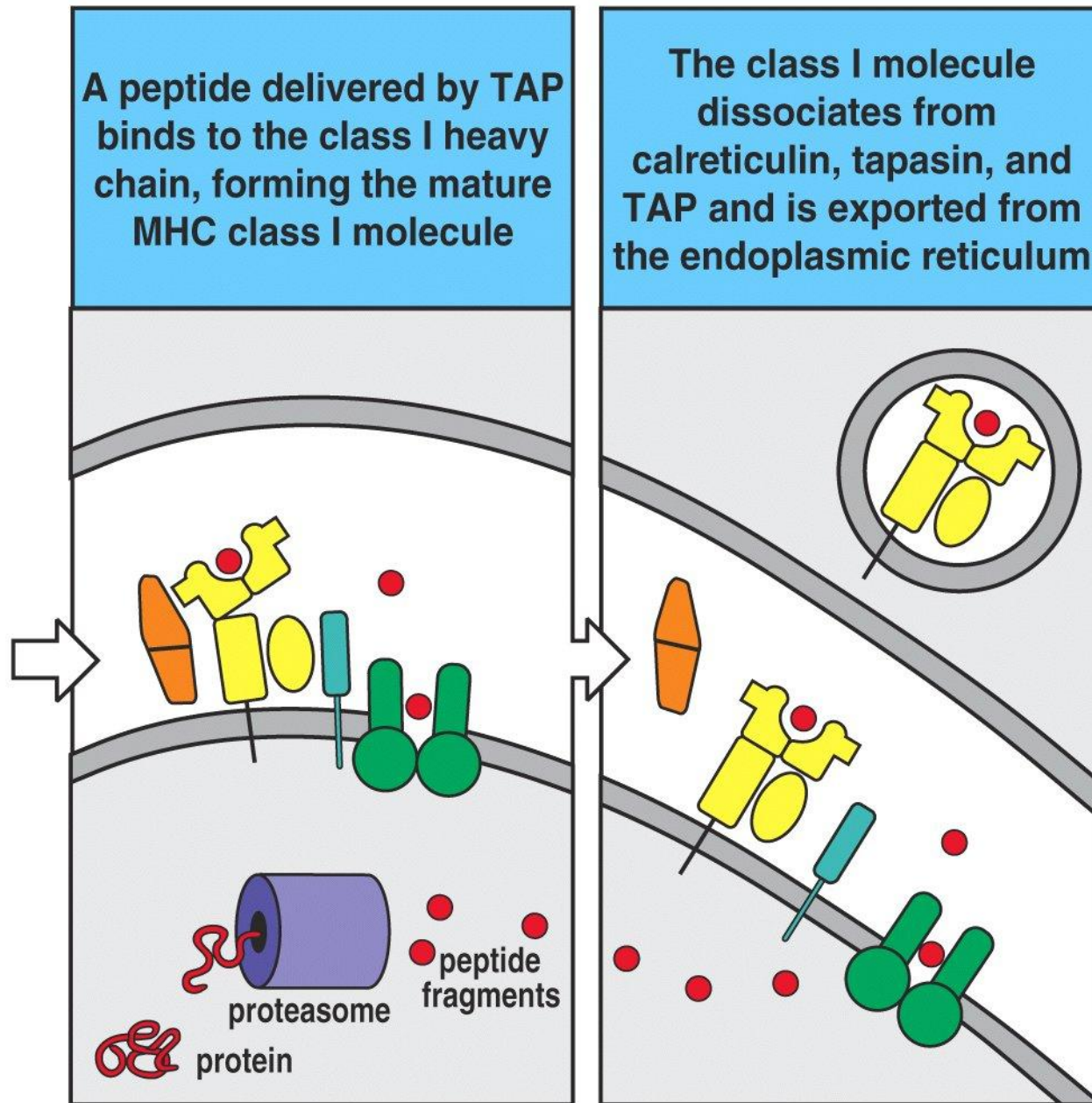


Figure 3-18 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

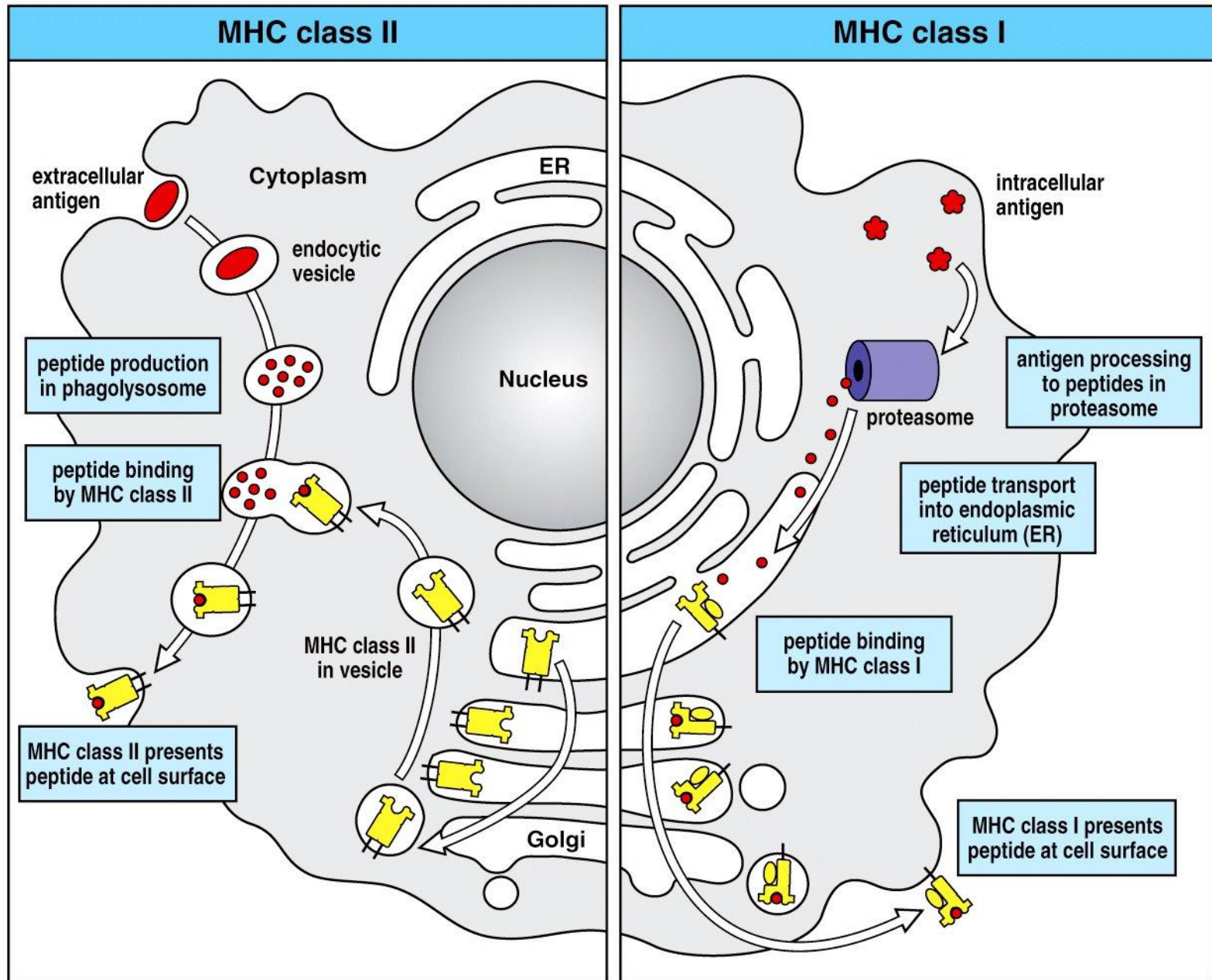


Figure 3-19 The Immune System, 2/e (© Garland Science 2005)

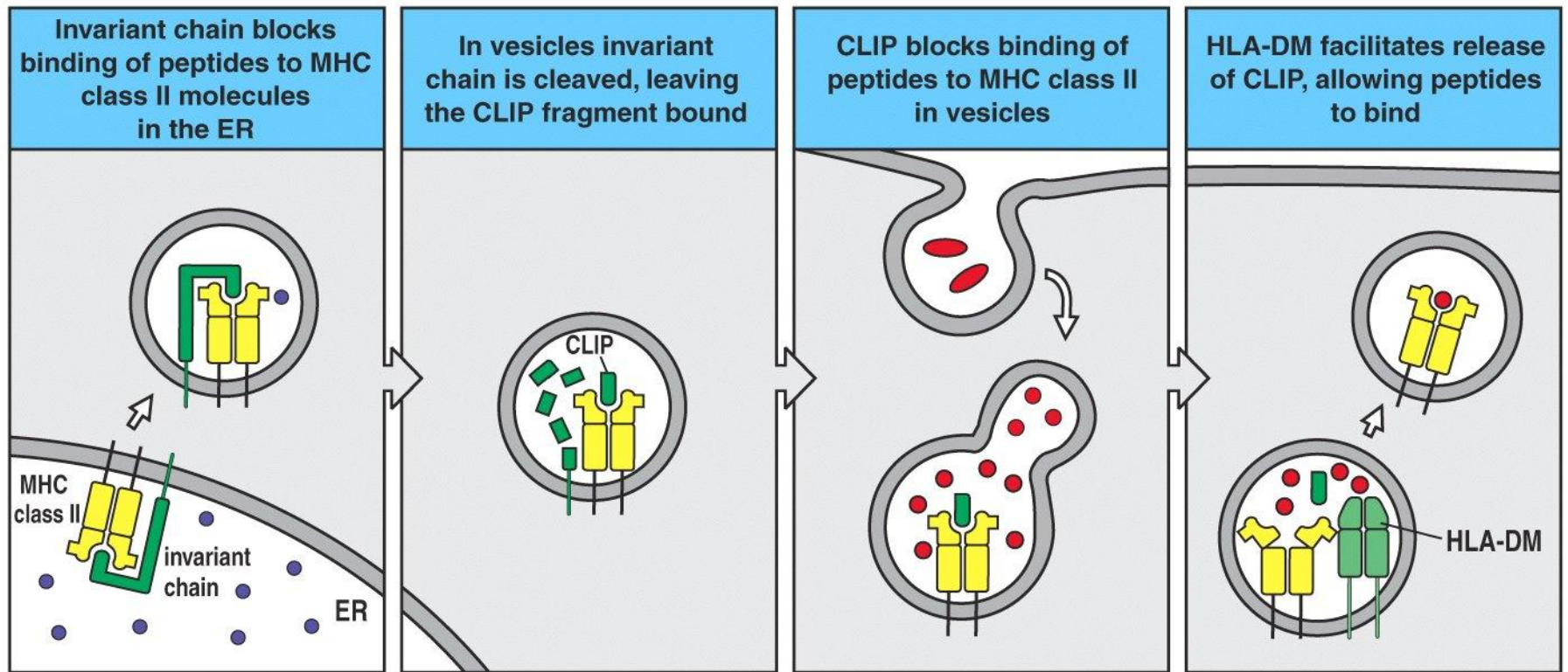
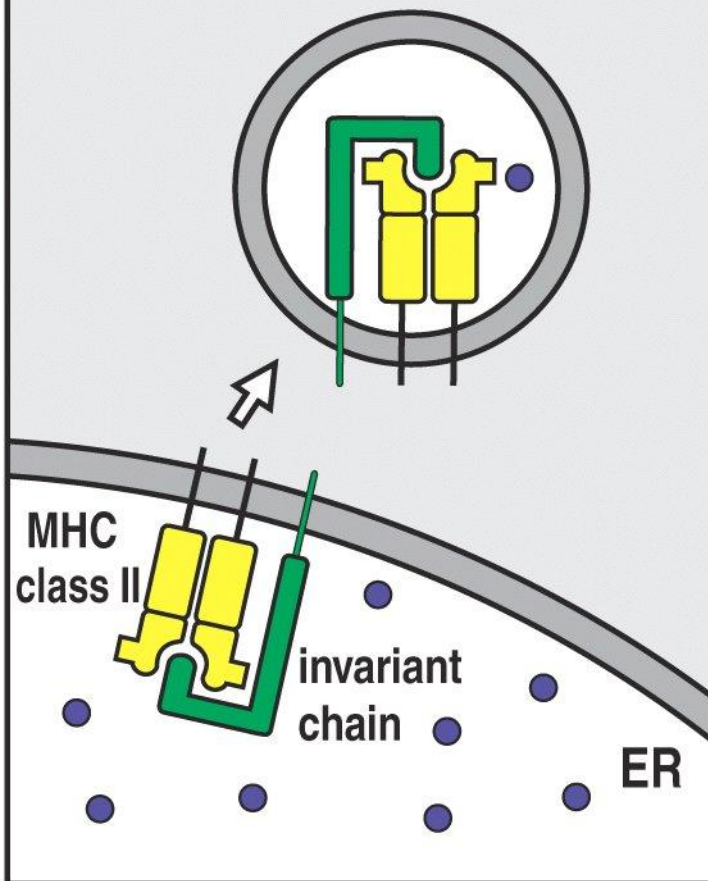


Figure 3-20 The Immune System, 2/e (© Garland Science 2005)

**Invariant chain blocks
binding of peptides to MHC
class II molecules
in the ER**



**In vesicles invariant
chain is cleaved, leaving
the CLIP fragment bound**

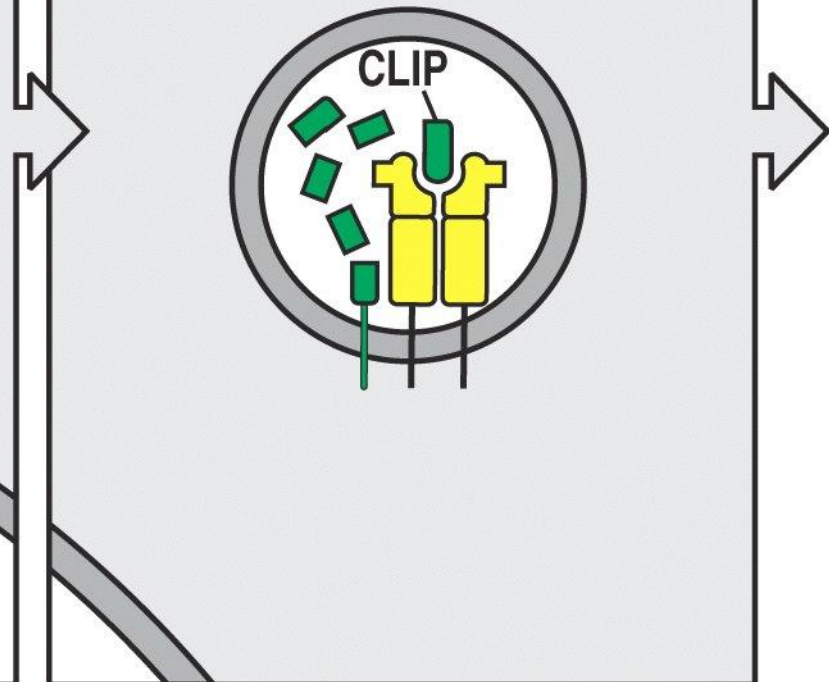


Figure 3-20 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

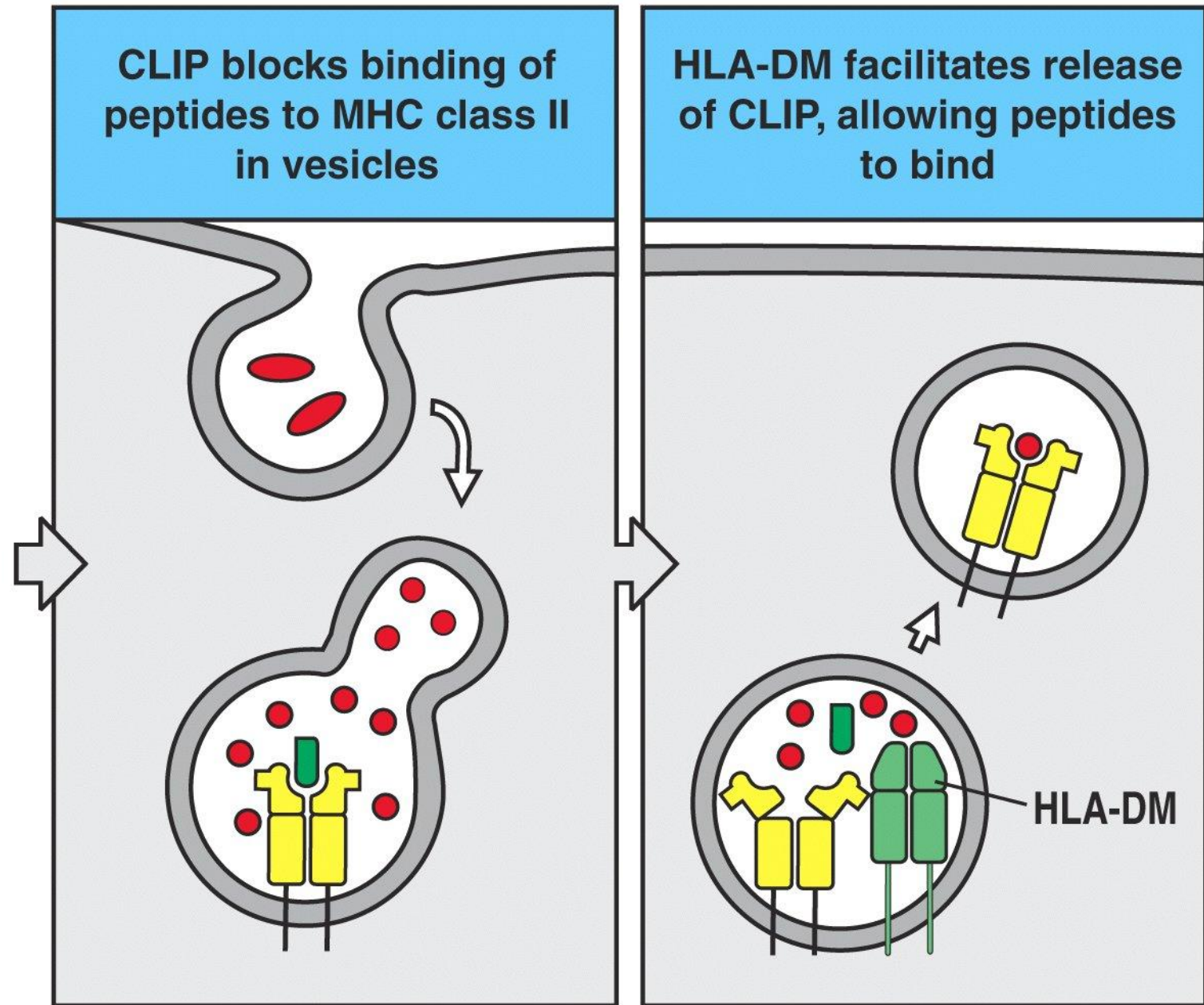


Figure 3-20 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

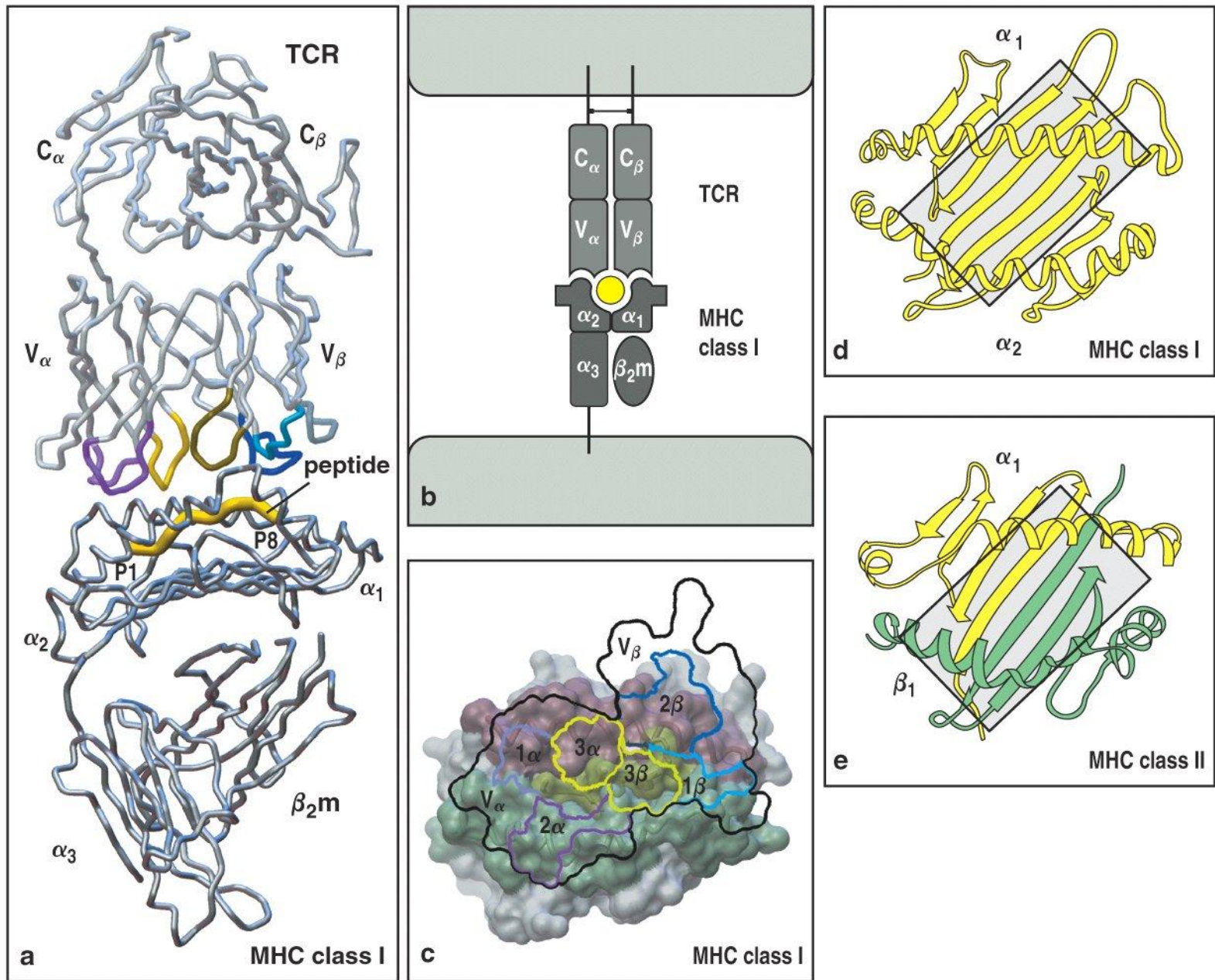


Figure 3-21 The Immune System, 2/e (© Garland Science 2005)

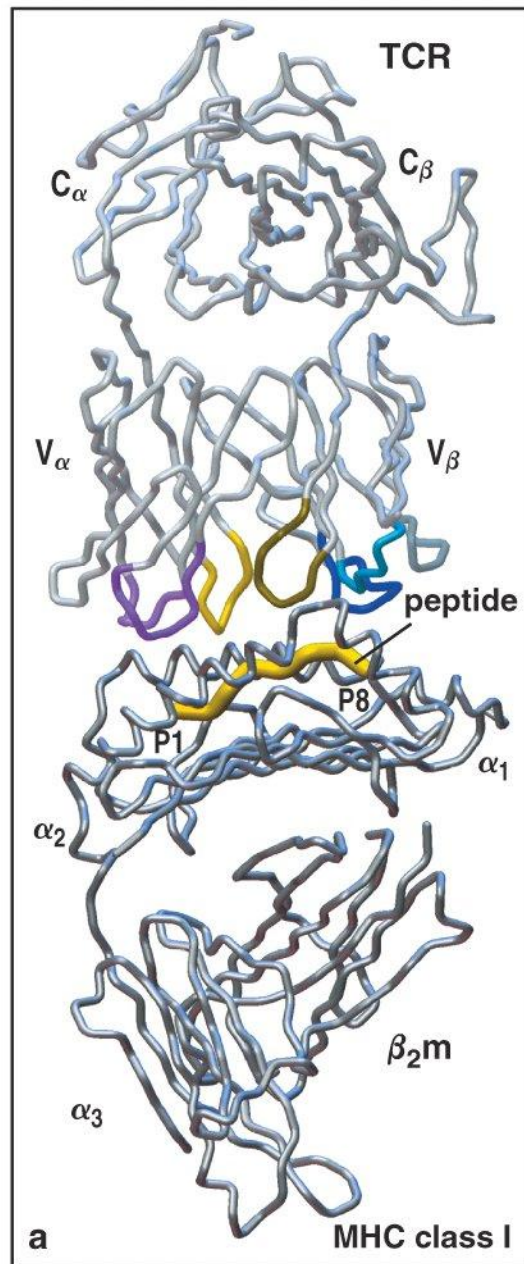


Figure 3-21 part 1 of 3 The Immune System, 2/e (© Garland Science 2005)

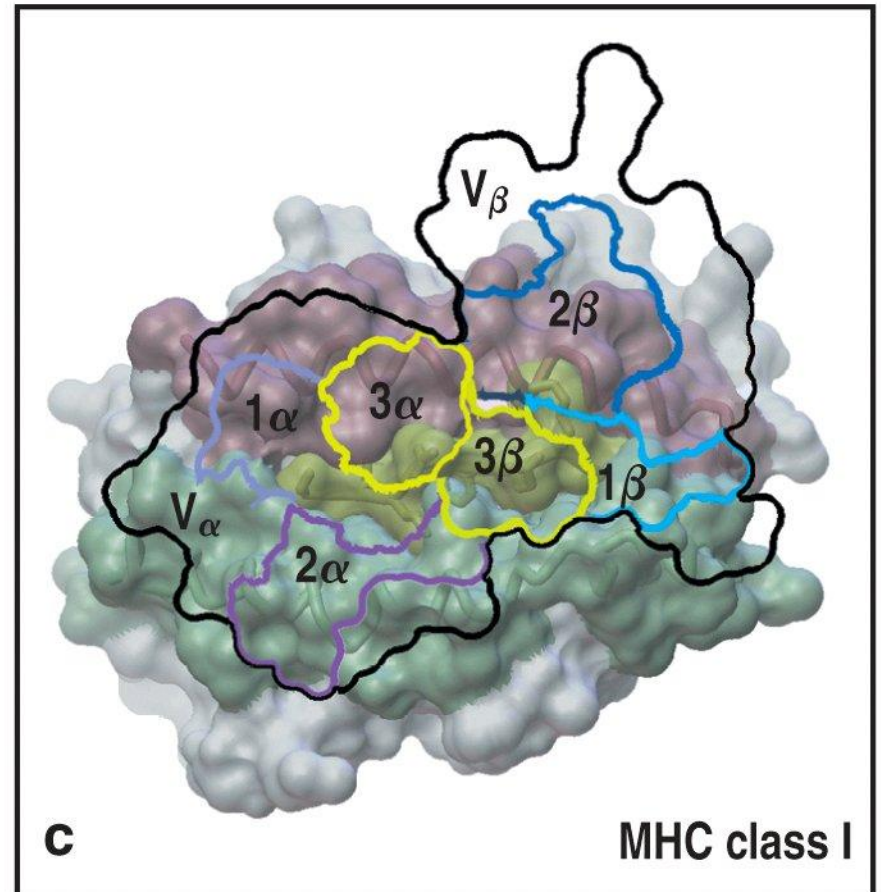
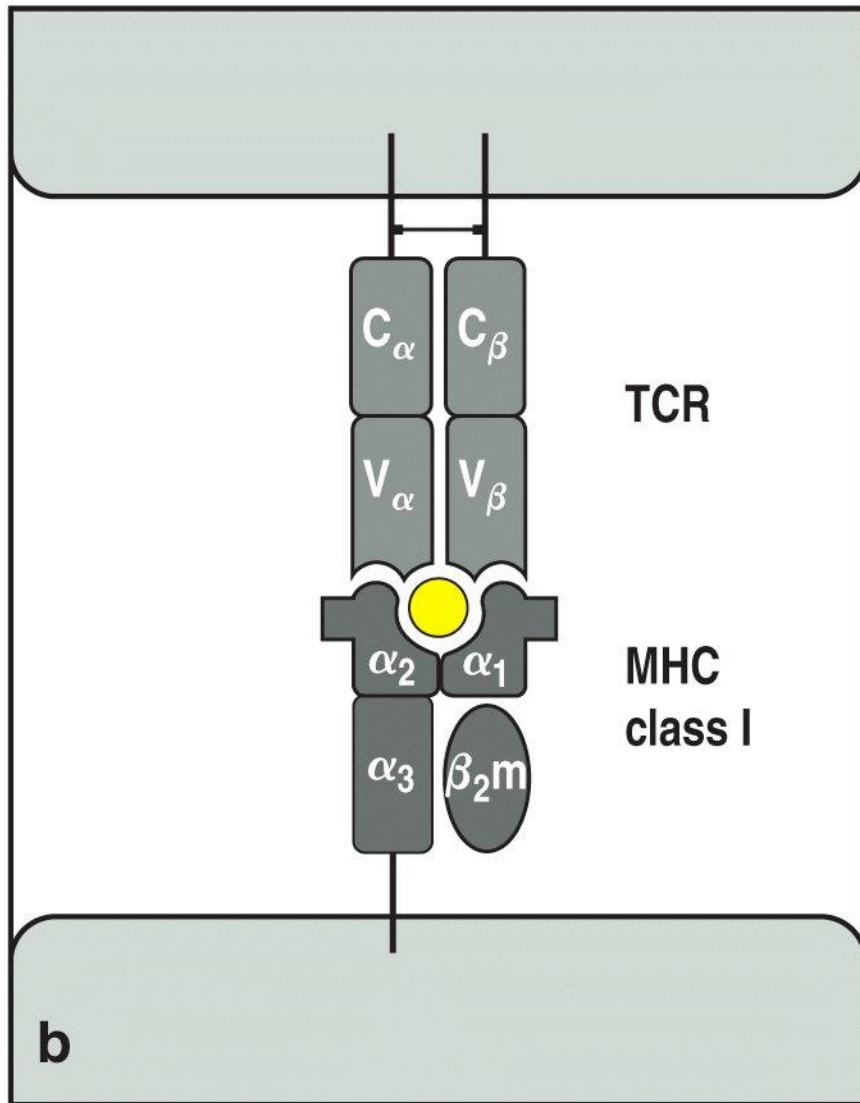


Figure 3-21 part 2 of 3 The Immune System, 2/e (© Garland Science 2005)

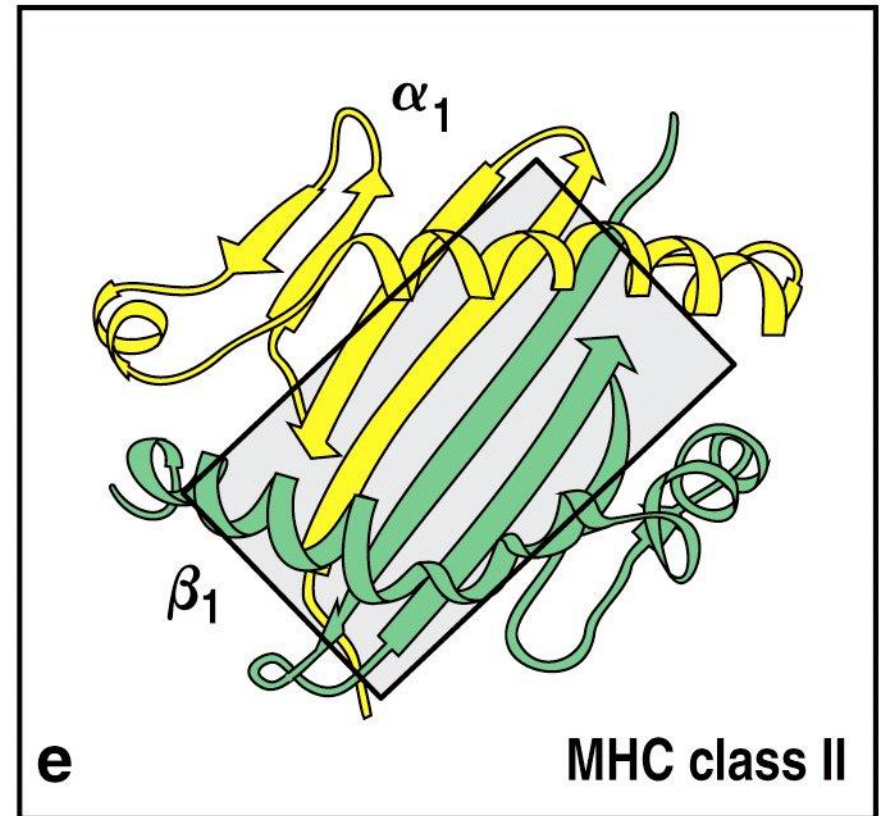
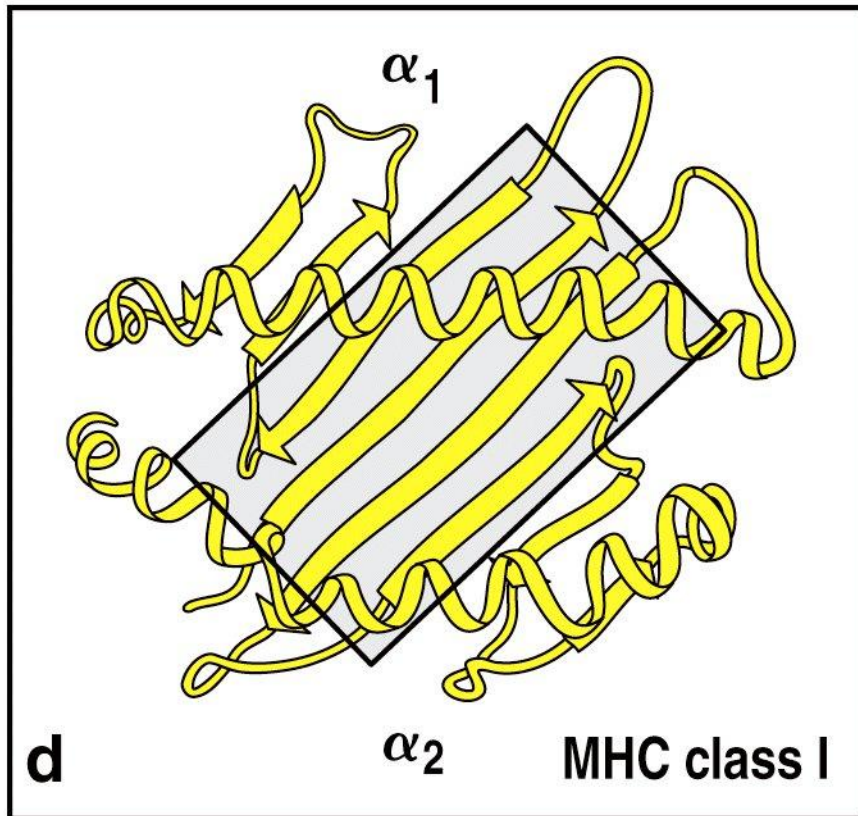


Figure 3-21 part 3 of 3 The Immune System, 2/e (© Garland Science 2005)

Tissue	MHC class I	MHC class II
Lymphoid tissues		
T cells	+++	+
B cells	+++	+++
Macrophages	+++	++
Other antigen-presenting cells (e.g., dendritic cells)	+++	+++
Epithelial cells of the thymus	+	+++
Other nucleated cells		
Neutrophils	+++	—
Hepatocytes	+	—
Kidney	+	—
Brain	+	— [†]
Non-nucleated cells		
Red blood cells	—	—

Figure 3-22 The Immune System, 2/e (© Garland Science 2005)

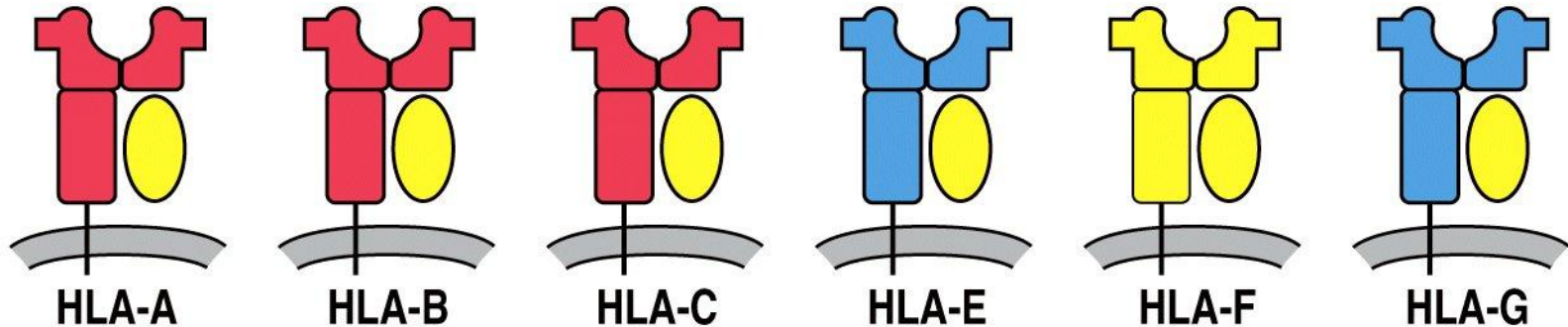
Tissue	MHC class I	MHC class II
Lymphoid tissues		
T cells	+++	+*
B cells	+++	+++
Macrophages	+++	++
Other antigen-presenting cells (e.g., dendritic cells)	+++	+++
Epithelial cells of the thymus	+	+++

Figure 3-22 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

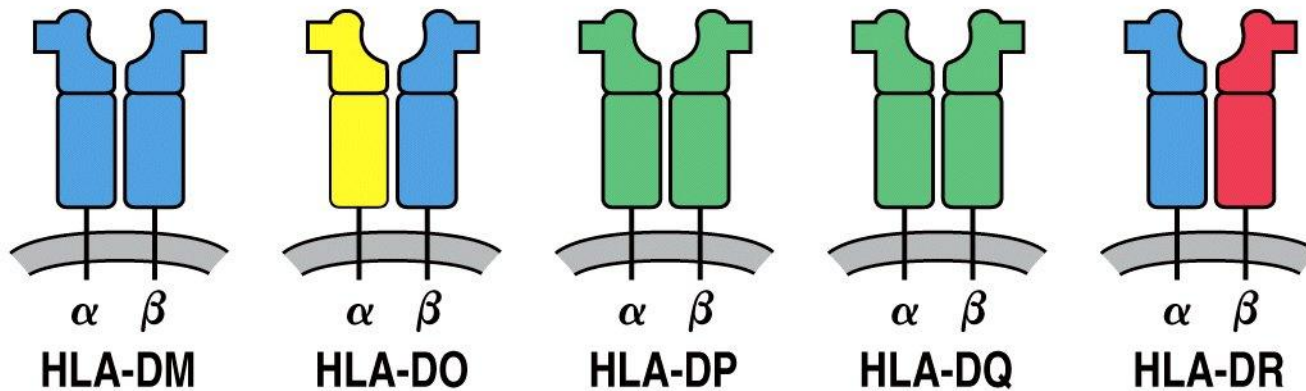
Tissue	MHC class I	MHC class II
Other nucleated cells		
Neutrophils	+++	-
Hepatocytes	+	-
Kidney	+	-
Brain	+	- †
Non-nucleated cells		
Red blood cells	-	-

Figure 3-22 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

Human MHC class I isotypes



Human MHC class II isotypes



■ highly polymorphic
 ■ polymorphic
 ■ oligomorphic
 ■ monomorphic

Figure 3-23 The Immune System, 2/e (© Garland Science 2005)

HLA polymorphism		
MHC class	HLA locus	Number of allotypes
MHC class I	A	218
	B	439
	C	96
	E	4
	F	1
	G	6
MHC class II	DMA	4
	DMB	6
	DOA	1
	DOB	2
	DPA1	12
	DPB1	88
	DQA1	17
	DQB1	42
	DRA	2
	DRB1	269
	DRB3	30
	DRB4	7
	DRB5	12

Figure 3-24 The Immune System, 2/e (© Garland Science 2005)

HLA polymorphism		
MHC class	HLA locus	Number of allotypes
MHC class I	A	218
	B	439
	C	96
	E	4
	F	1
	G	6

Figure 3-24 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

HLA polymorphism		
MHC class	HLA locus	Number of allotypes
MHC class II	DMA	4
	DMB	6
	DOA	1
	DOB	2
	DPA1	12
	DPB1	88
	DQA1	17
	DQB1	42
	DRA	2
	DRB1	269
	DRB3	30
	DRB4	7
	DRB5	12

Figure 3-24 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

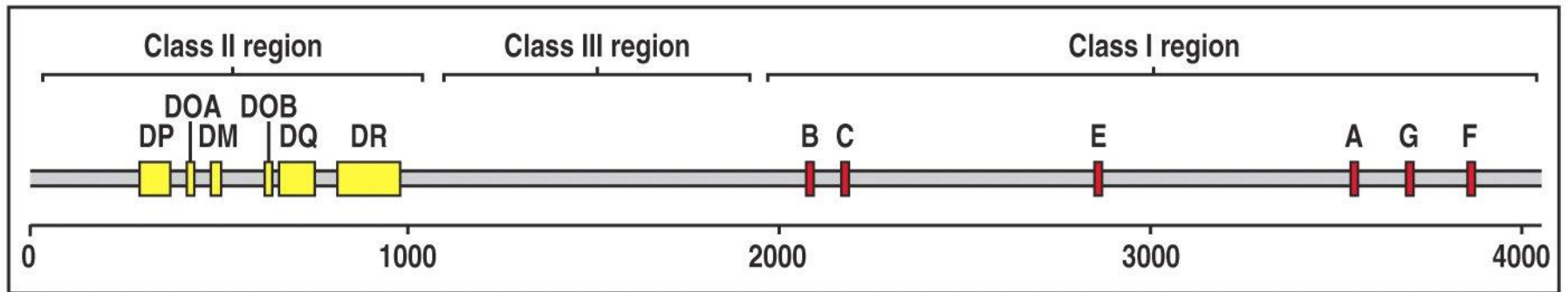


Figure 3-25 The Immune System, 2/e (© Garland Science 2005)

Diversity of gene content in the HLA-DR subdivision

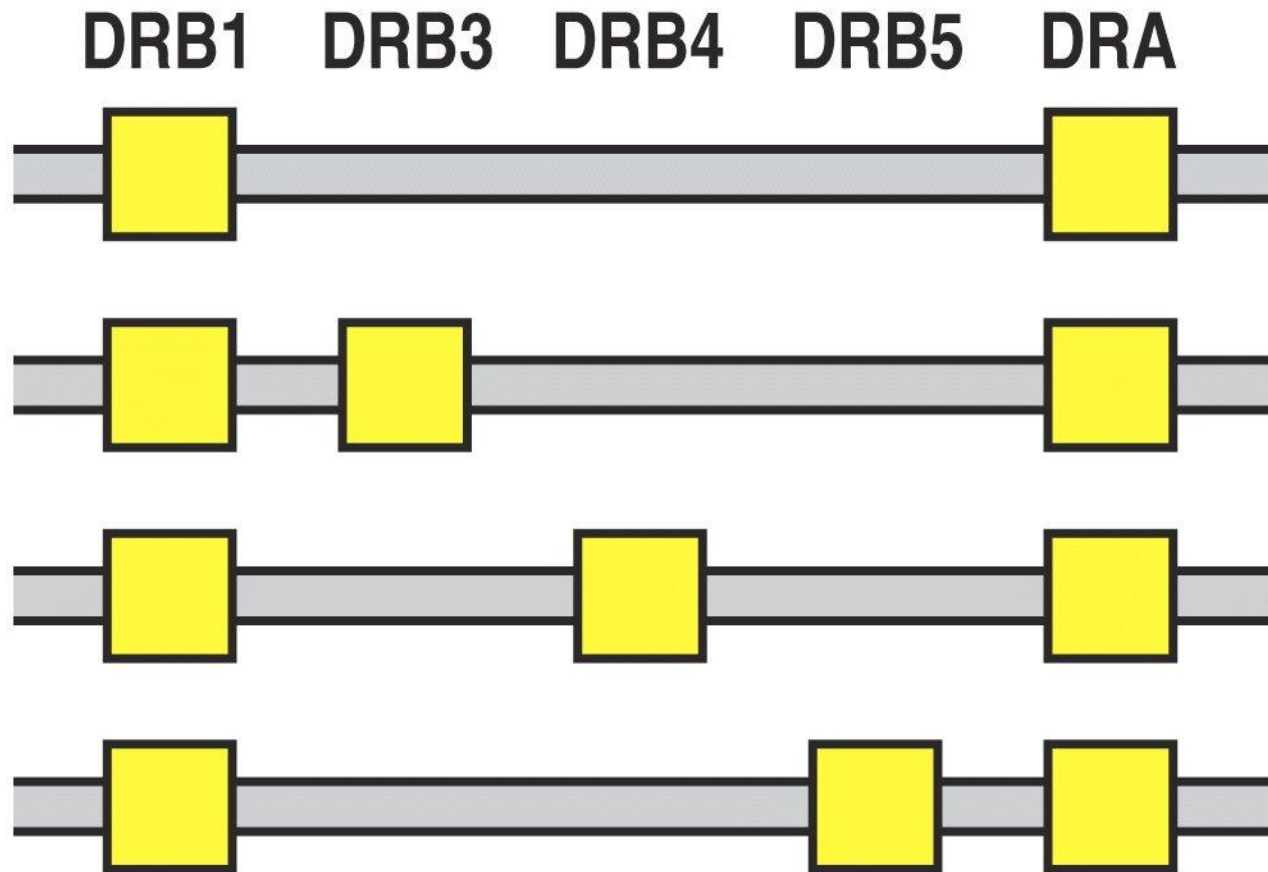


Figure 3-26 The Immune System, 2/e (© Garland Science 2005)

HLA class II region

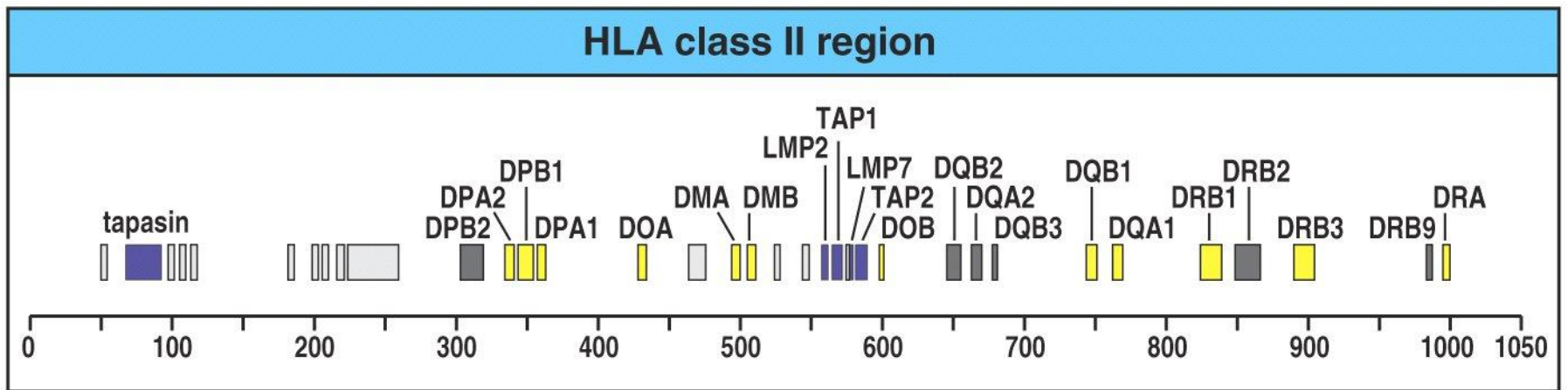
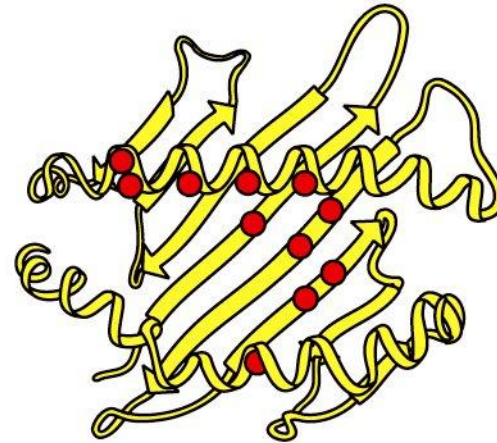
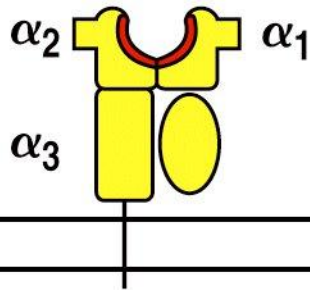


Figure 3-27 The Immune System, 2/e (© Garland Science 2005)

MHC class I variability



MHC class II variability

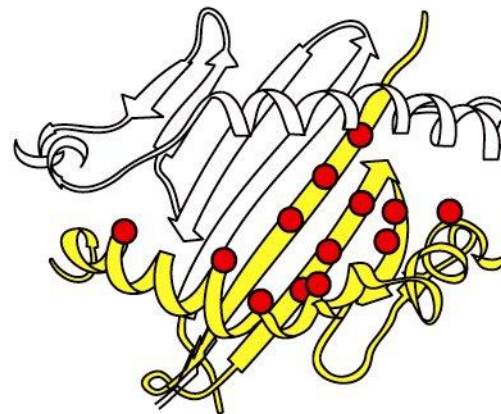
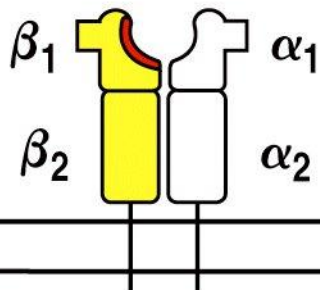


Figure 3-28 The Immune System, 2/e (© Garland Science 2005)

MHC class I variability

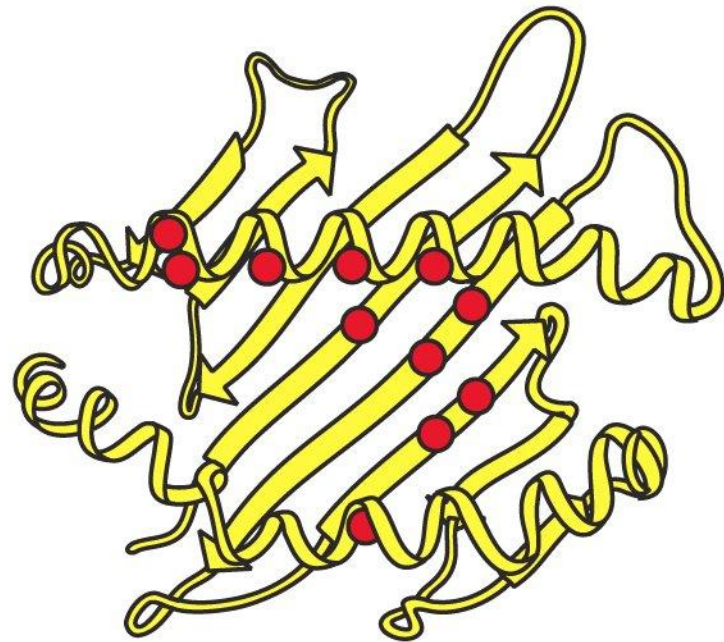
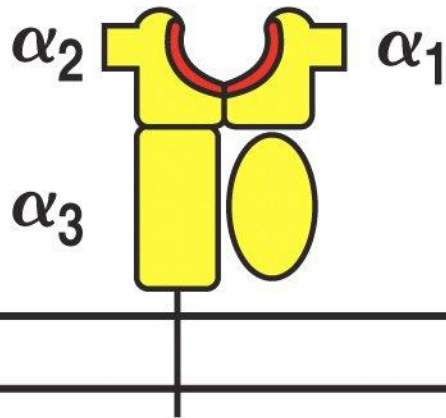


Figure 3-28 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

MHC class II variability

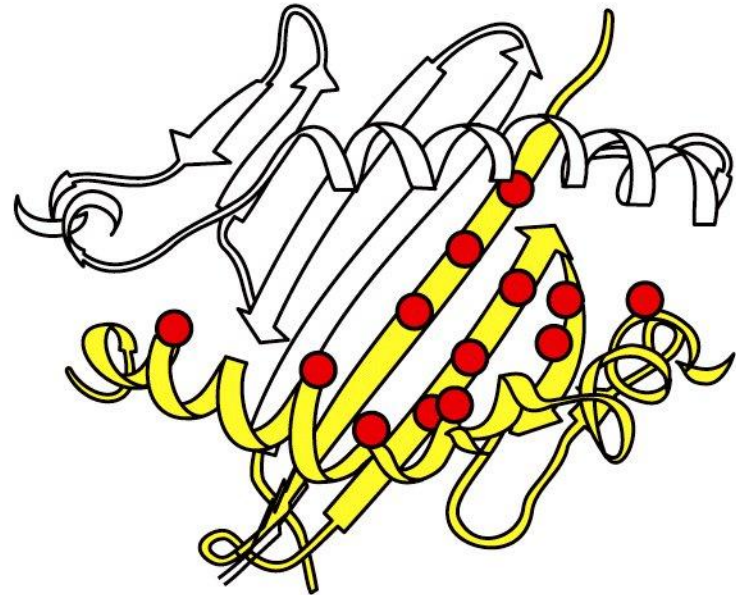
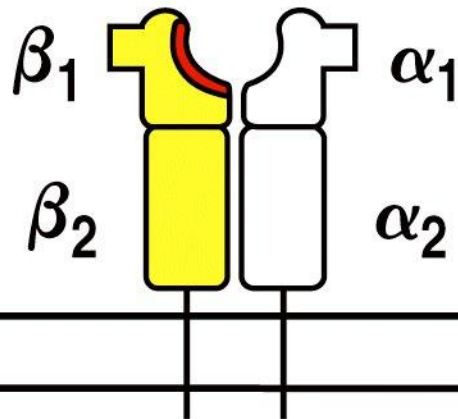


Figure 3-28 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

MHC molecule		Amino-acid sequence of peptide-binding motifs and bound peptides	Source of bound peptide
		Position in peptide sequence N—1 2 3 4 5 6 7 8 9—C	
Class I	HLA-A*0201	Peptide-binding motif: [] (L/M) [] [] [] (V) [] [] (V/L) Bound peptide: [I] (L) [K] [E] [P] (V) [H] [G] (V)	HIV reverse transcriptase
	HLA-B*2705	Peptide-binding motif: [] (R) [] [] [] [] [] (L/F) Bound peptide: [R] (R) [Y] [P] [D] [A] [V] [Y] (L)	Measles virus F protein
Class II	HLA-DRB1*0401	Self peptide: [G] [V] [Y] [F] (Y) [L] [Q] (W) [G] [R] [S] [T] (L) [V] [S] [V] [S]	Igκ light chain
	HLA-DQA1*0501 HLA-DQB1*0301	Self peptide: [I] [P] [E] (L) [N] [K] [V] [A] [R] [A] [A] [A]	Transferrin receptor

Figure 3-29 The Immune System, 2/e (© Garland Science 2005)

MHC restriction

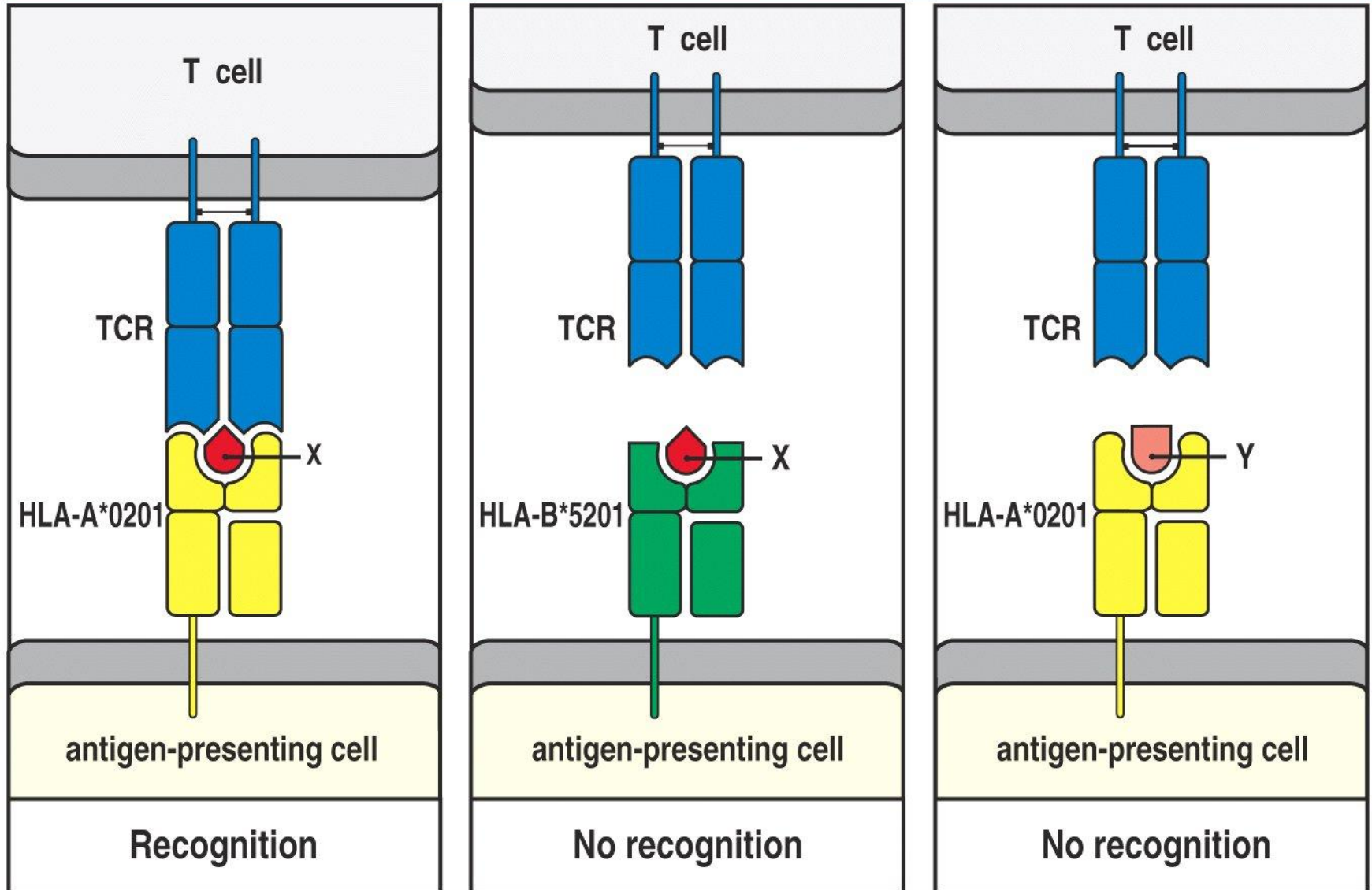
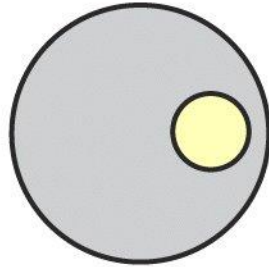
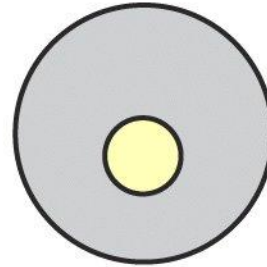


Figure 3-30 The Immune System, 2/e (© Garland Science 2005)

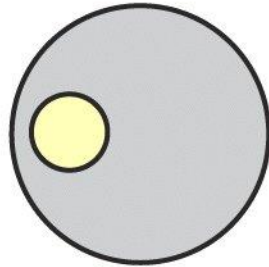
Heterozygote advantage in peptide selection



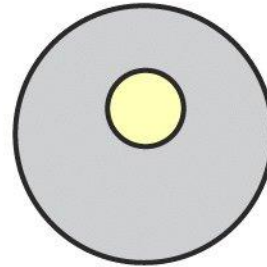
Haplotype 1



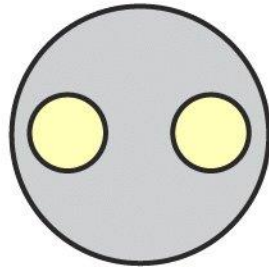
Haplotype 3



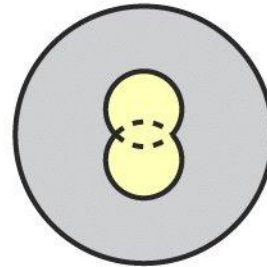
Haplotype 2



Haplotype 4



Haplotypes 1 + 2



Haplotypes 3 + 4

Figure 3-31 The Immune System, 2/e (© Garland Science 2005)

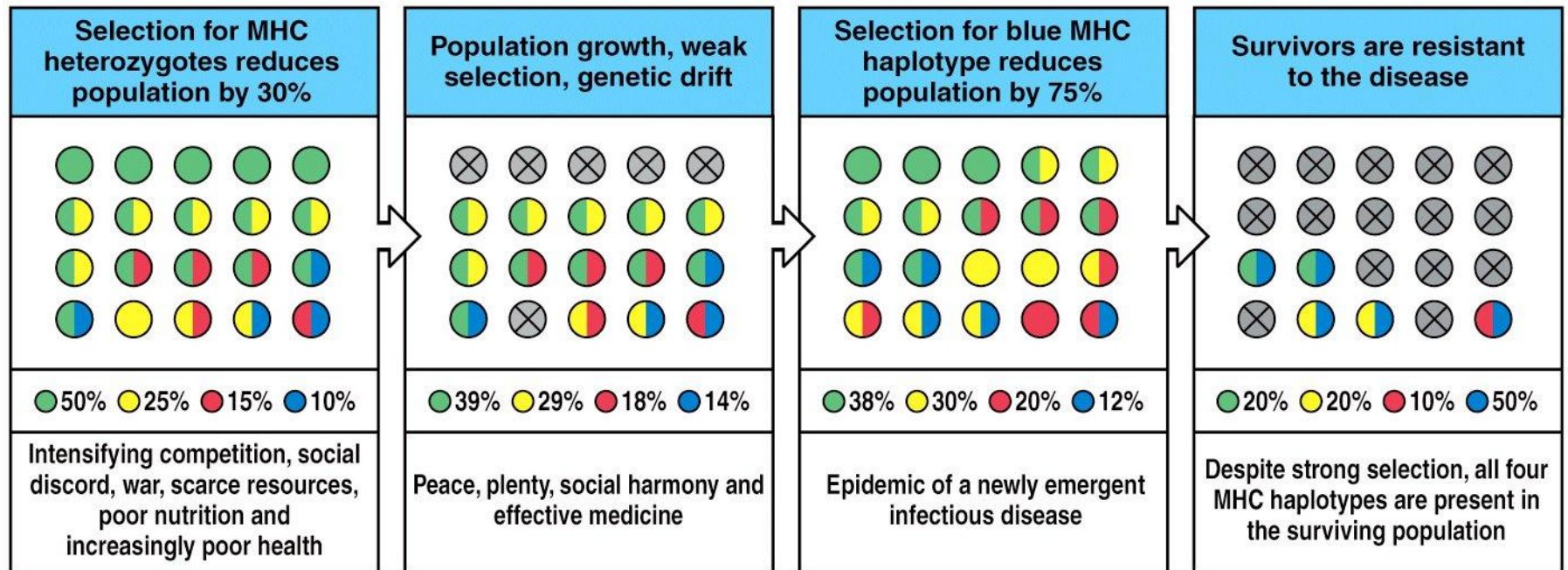


Figure 3-32 The Immune System, 2/e (© Garland Science 2005)

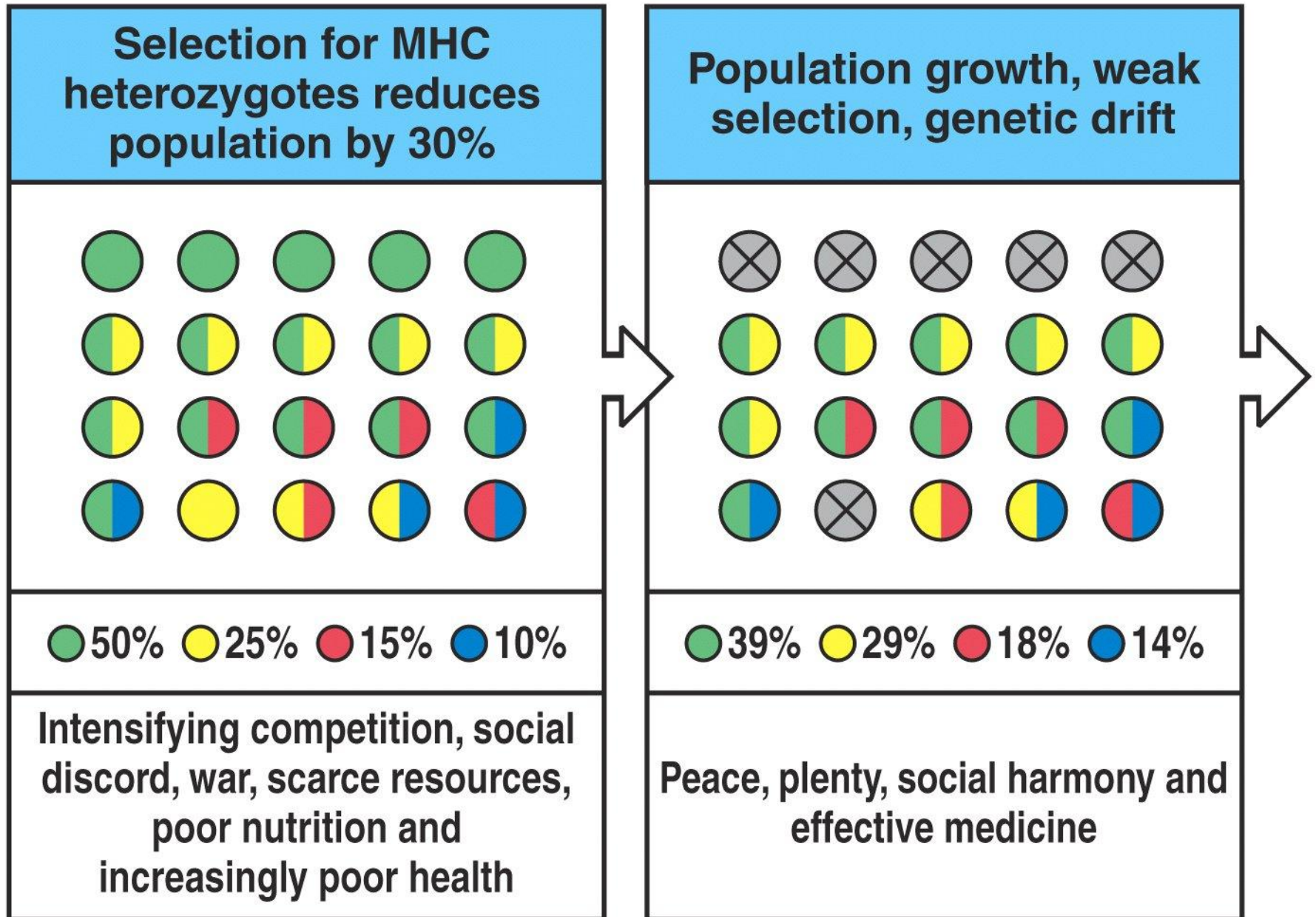


Figure 3-32 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

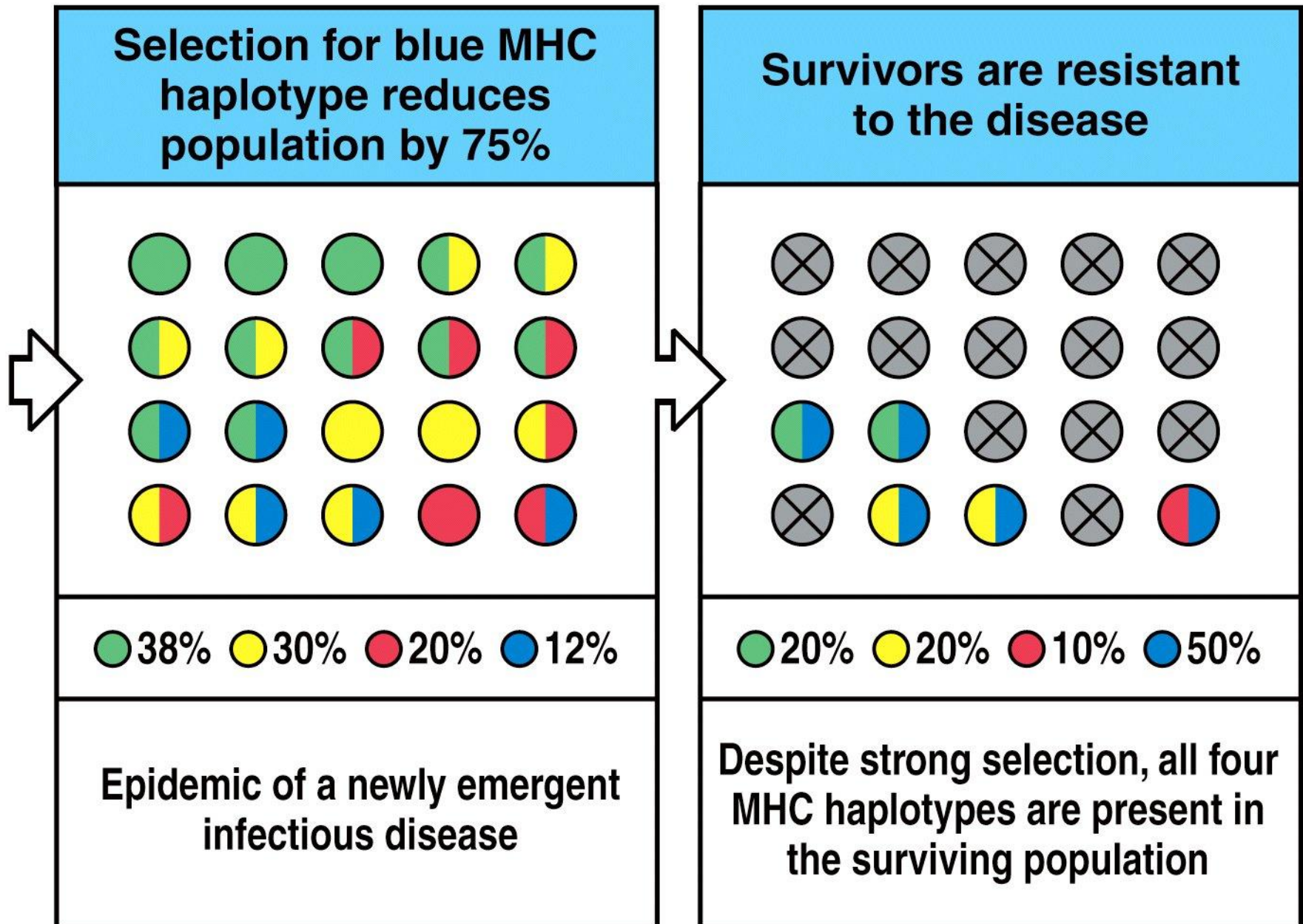


Figure 3-32 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

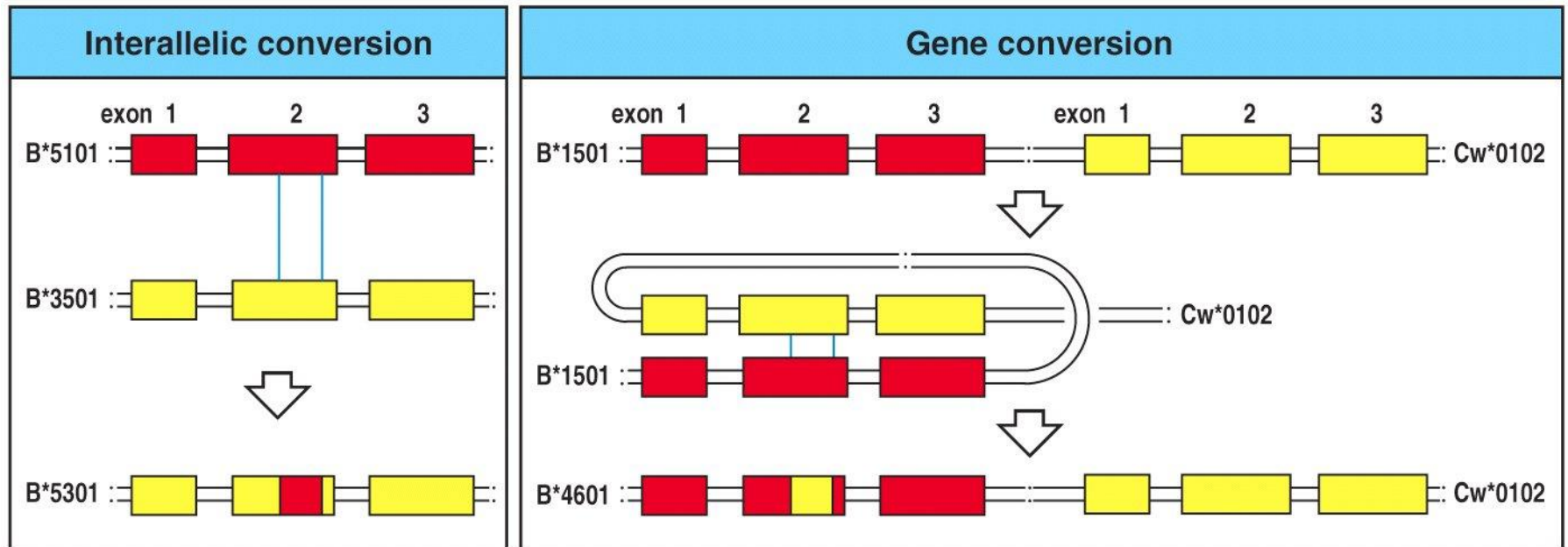


Figure 3-33 The Immune System, 2/e (© Garland Science 2005)

Interallelic conversion

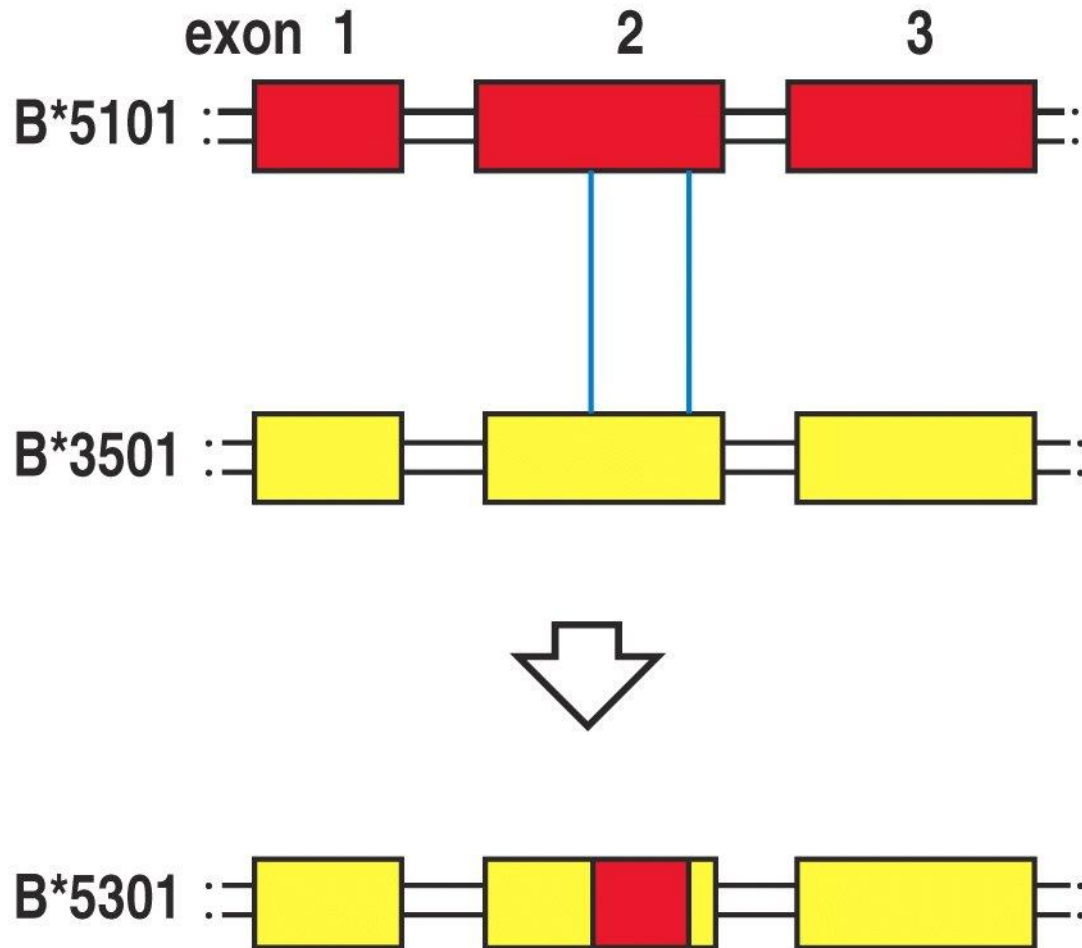


Figure 3-33 part 1 of 2 The Immune System, 2/e (© Garland Science 2005)

Gene conversion

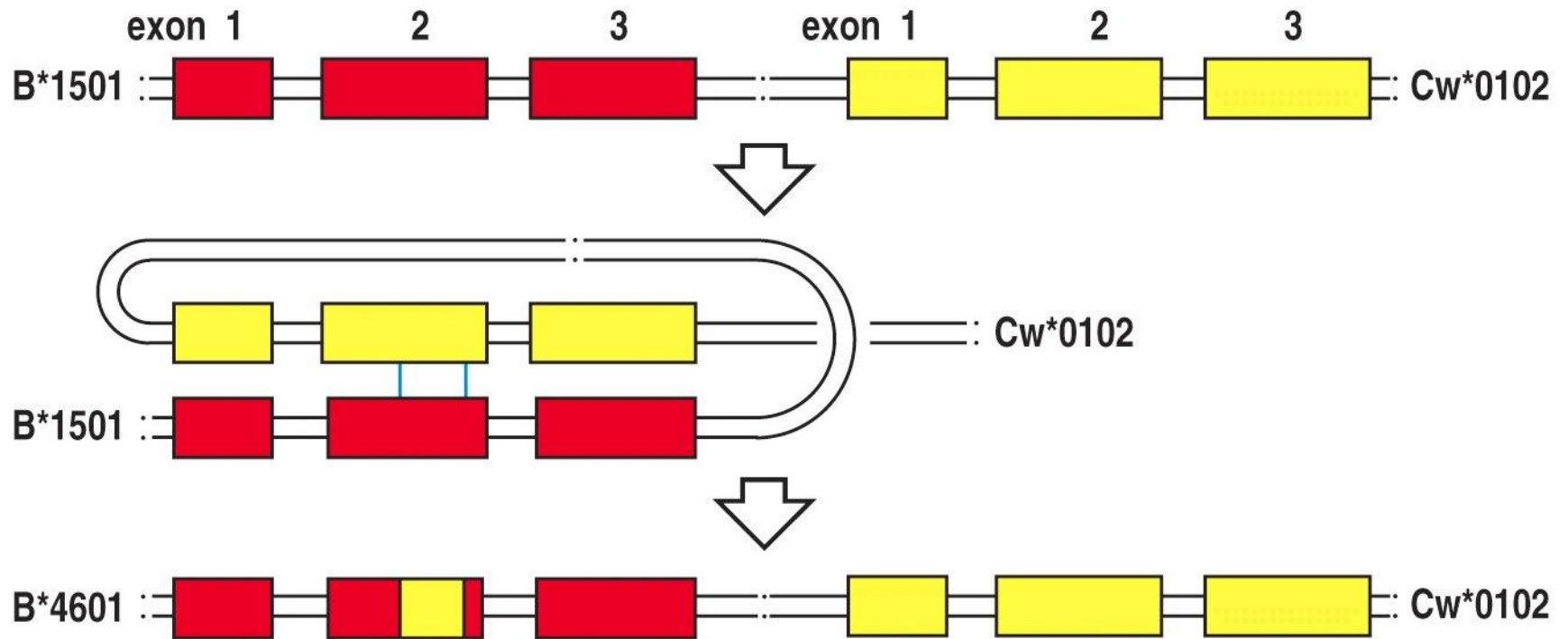


Figure 3-33 part 2 of 2 The Immune System, 2/e (© Garland Science 2005)

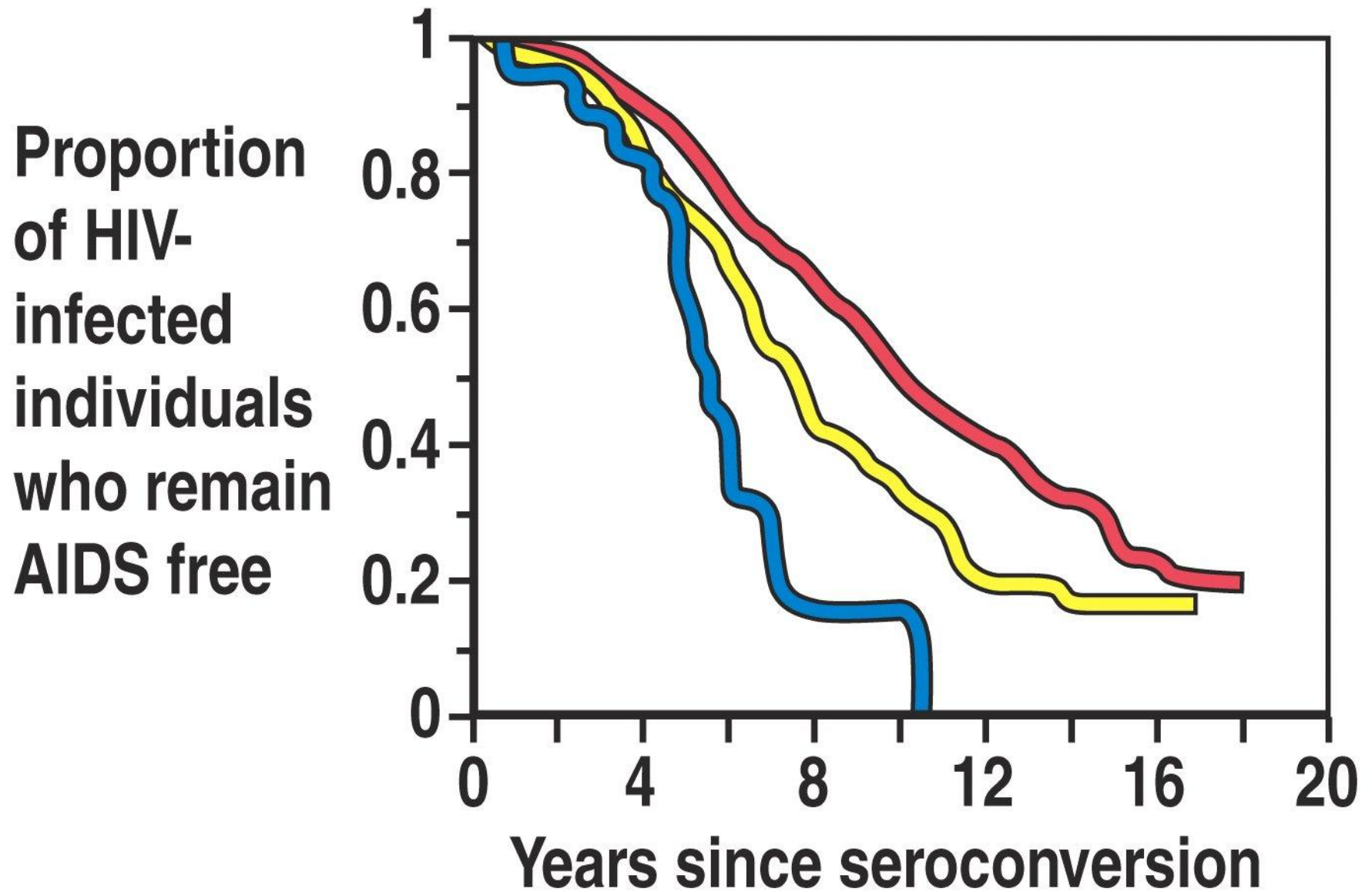


Figure 3-34 The Immune System, 2/e (© Garland Science 2005)