

**FIGURE 9-1** The key initial step in any immune response is the presentation of antigens by antigen-processing cells to antigen-sensitive cells. This step is performed by major histocompatibility complex (*MHC*) molecules located on the surface of antigen-processing cells.

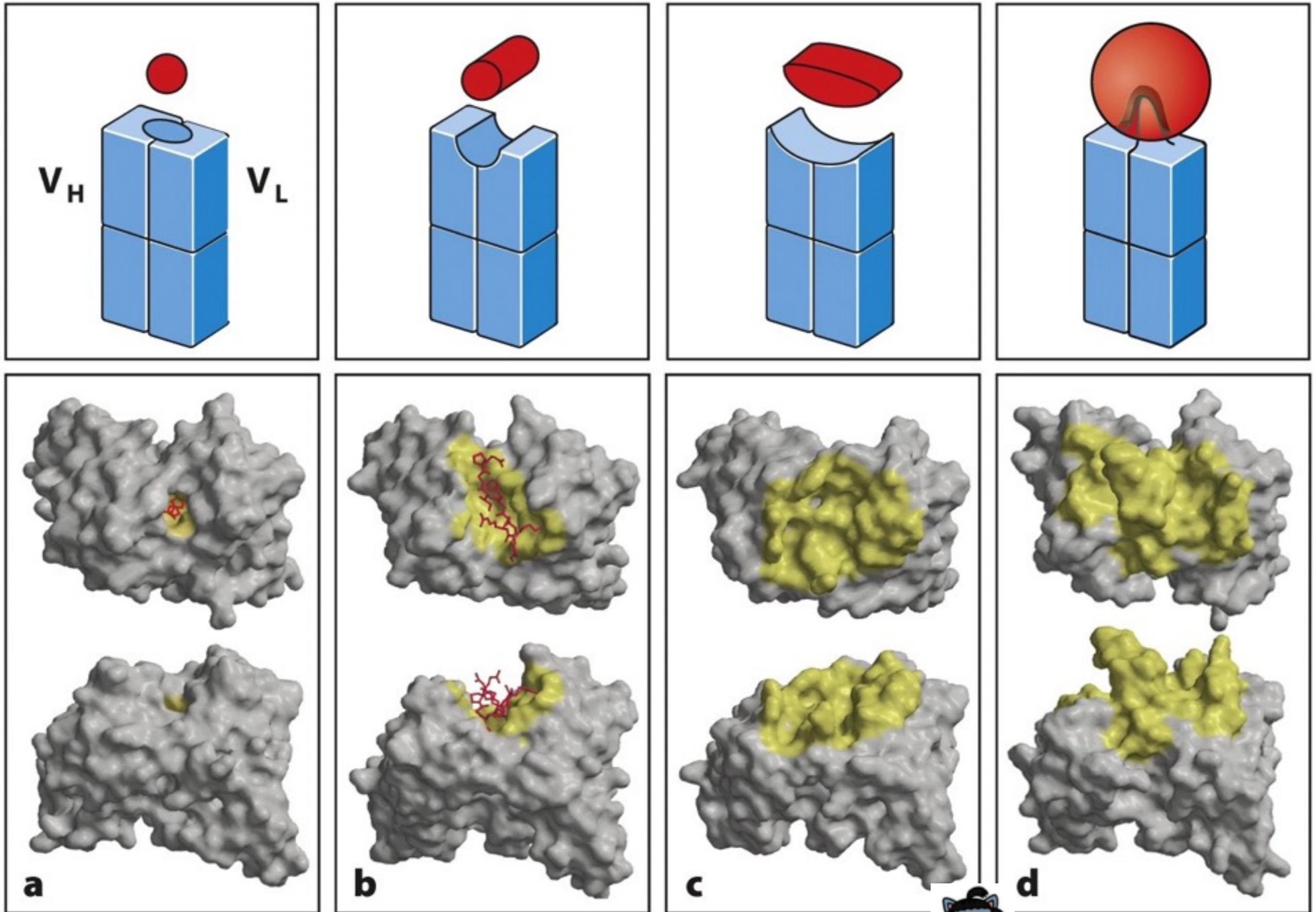


Figure 4.8 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



conceito importante!

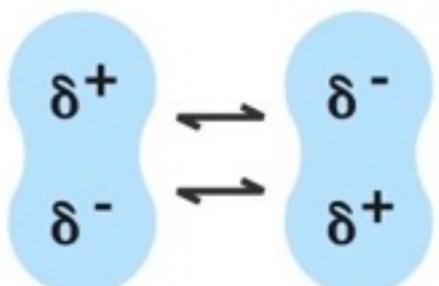
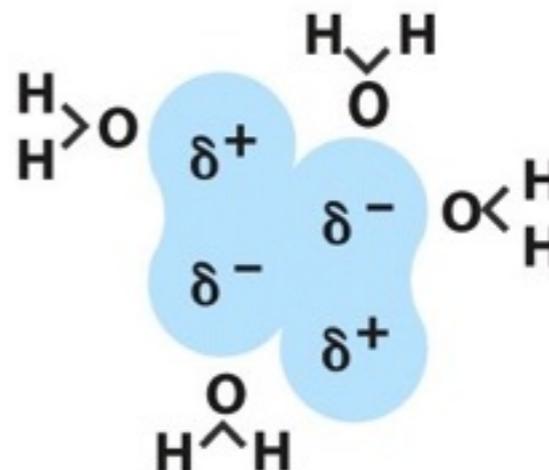
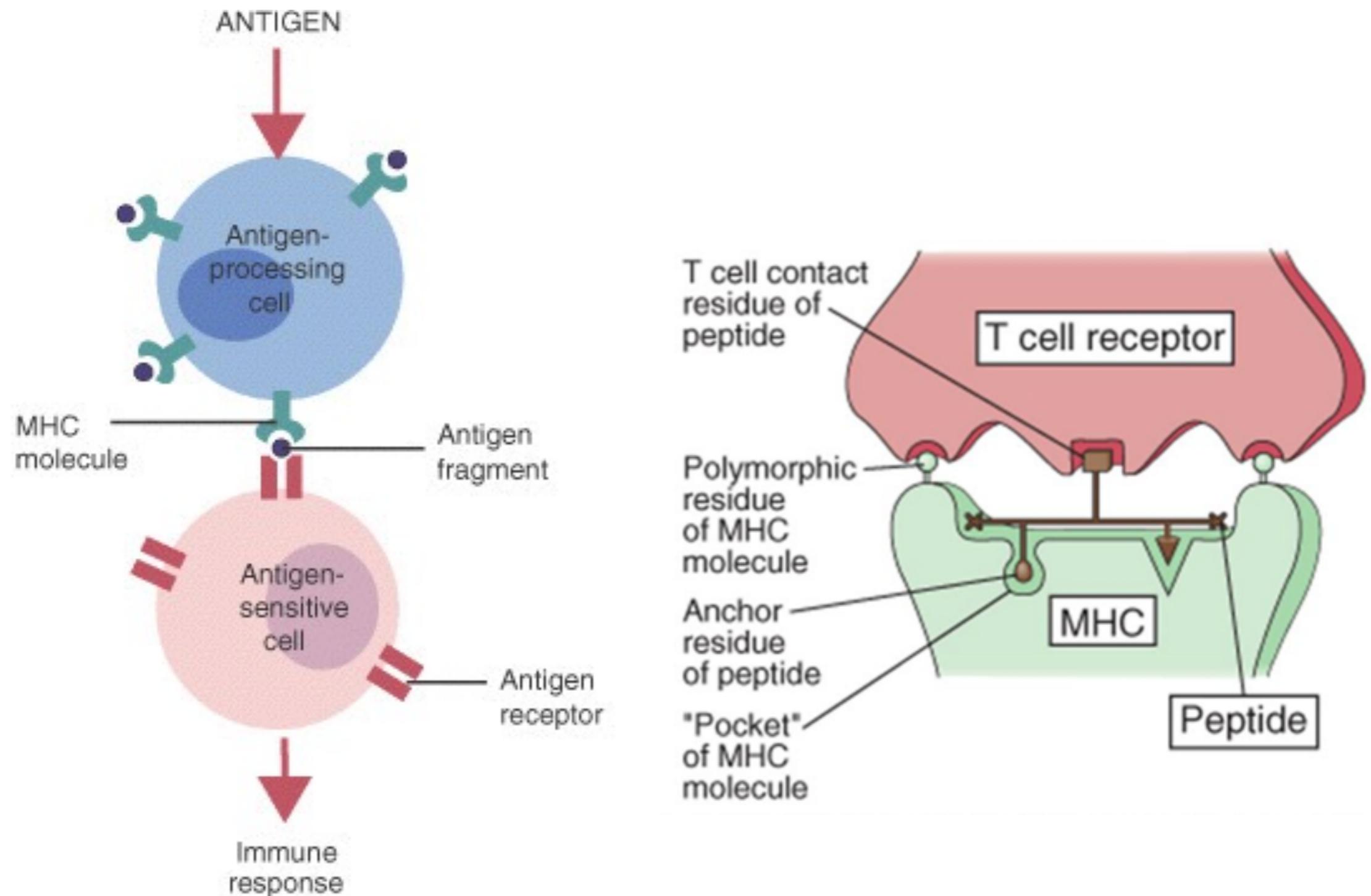
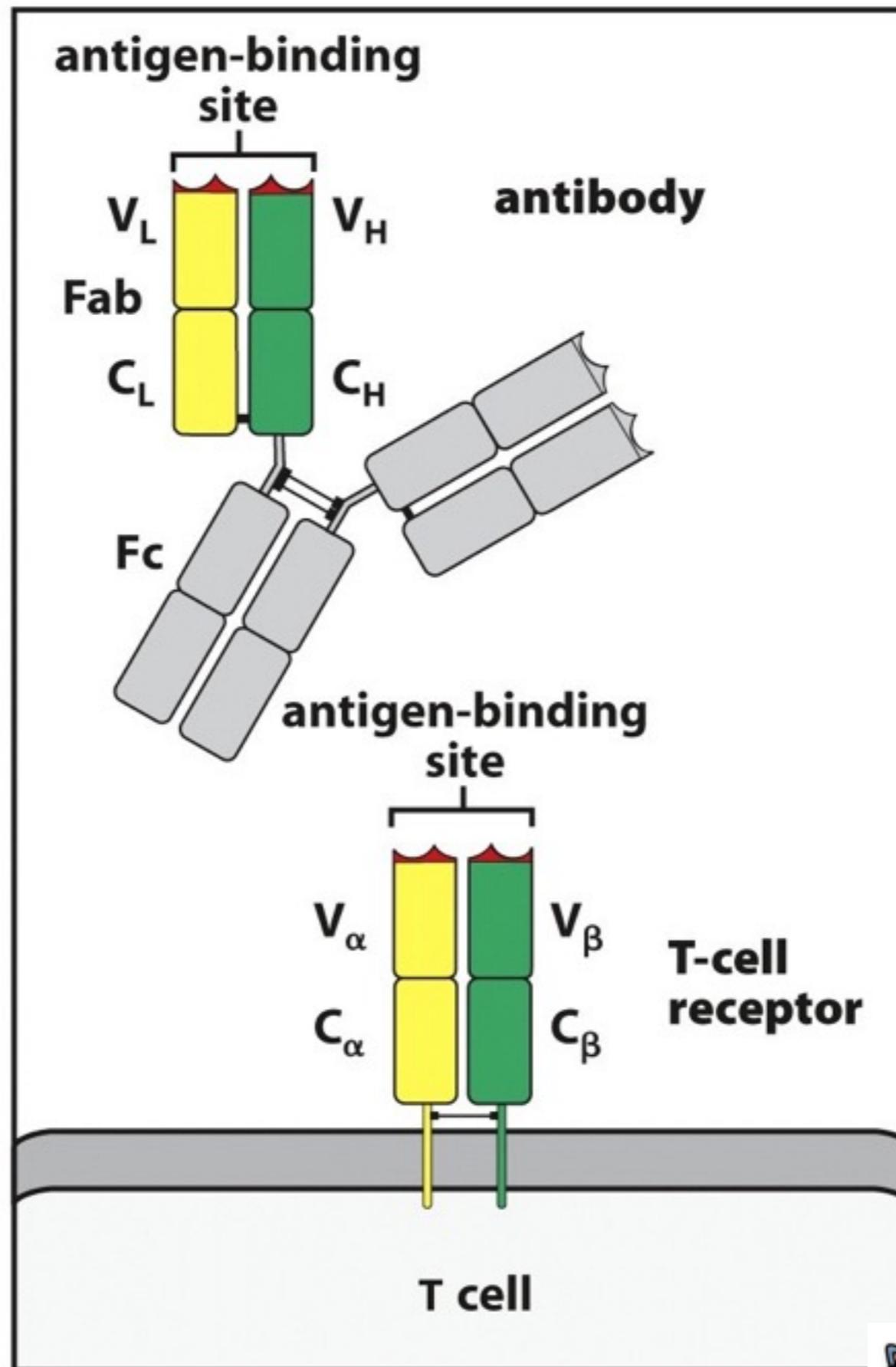
Noncovalent forces	Origin	
Electrostatic forces	Attraction between opposite charges	$-\overset{\oplus}{\text{N}}\text{H}_3 \quad \overset{\ominus}{\text{O}}\text{OC}-$
Hydrogen bonds	Hydrogen shared between electronegative atoms (N,O)	$\begin{array}{c} \diagdown \text{N} - \text{H} - - \text{O} = \text{C} \diagup \\ \delta^- \quad \delta^+ \quad \delta^- \end{array}$
Van der Waals forces	Fluctuations in electron clouds around molecules polarize neighboring atoms oppositely	
Hydrophobic forces	Hydrophobic groups interact unfavorably with water and tend to pack together to exclude water molecules. The attraction also involves van der Waals forces	

Figure 4.9 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



**FIGURE 9-1** The key initial step in any immune response is the presentation of antigens by antigen-processing cells to antigen-sensitive cells. This step is performed by major histocompatibility complex (*MHC*) molecules located on the surface of antigen-processing cells.



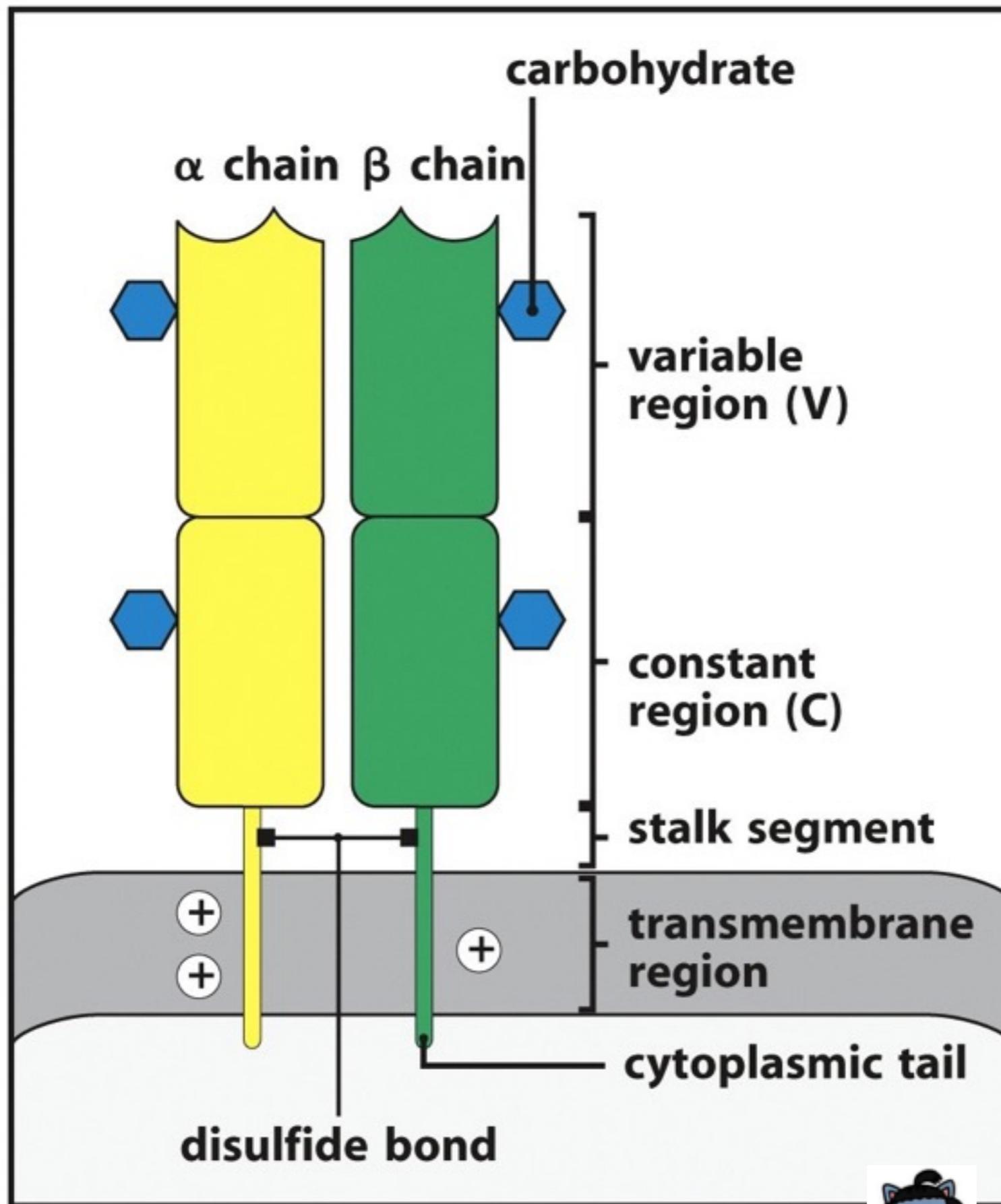
B  
C  
R  
Cell  
Receptor

T  
C  
R  
Cell  
Receptor

Figure 4.11 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



conceito importante!

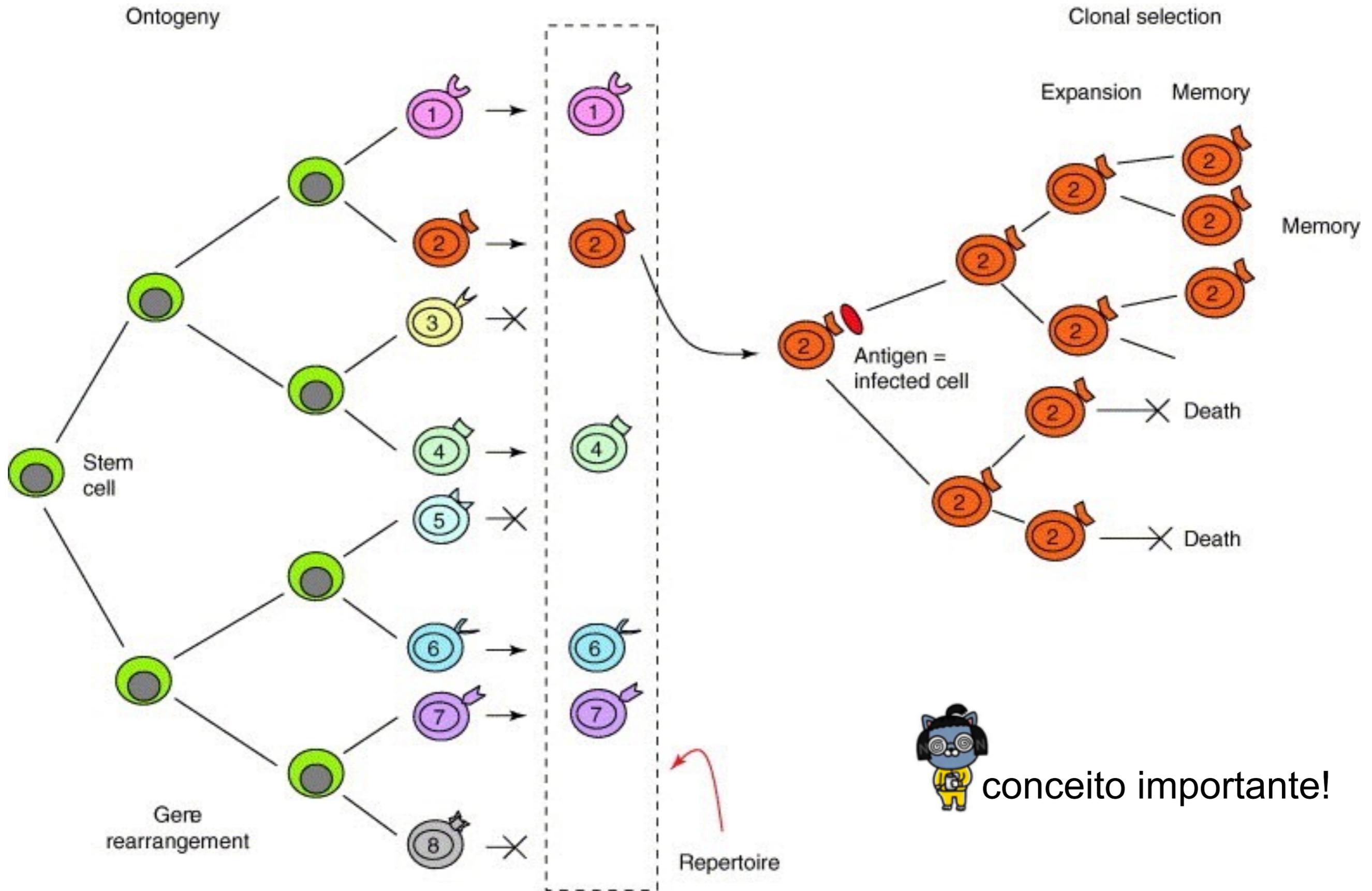


T  
Cell  
Receptor

Figure 4.12 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



conceito importante!



conceito importante!

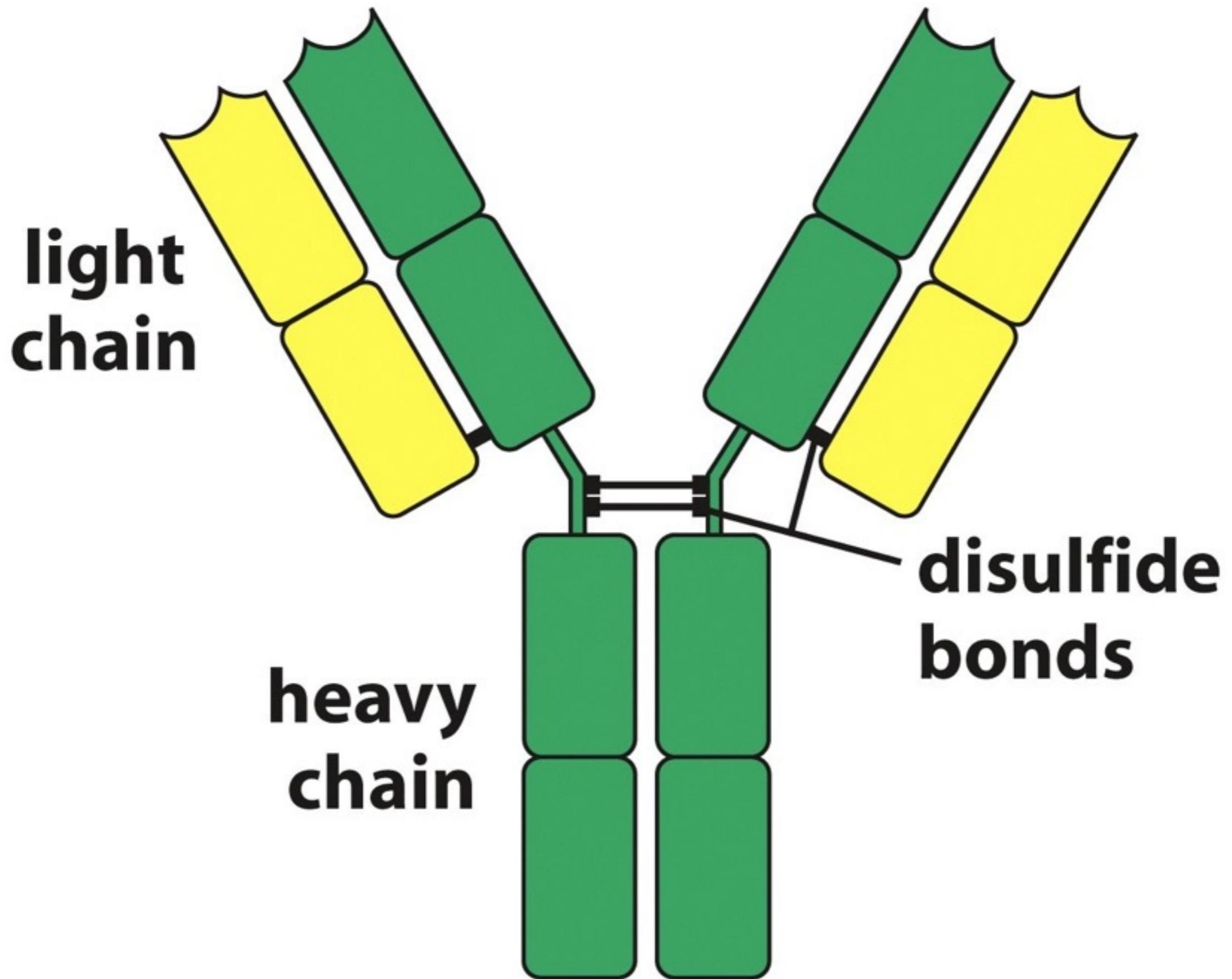
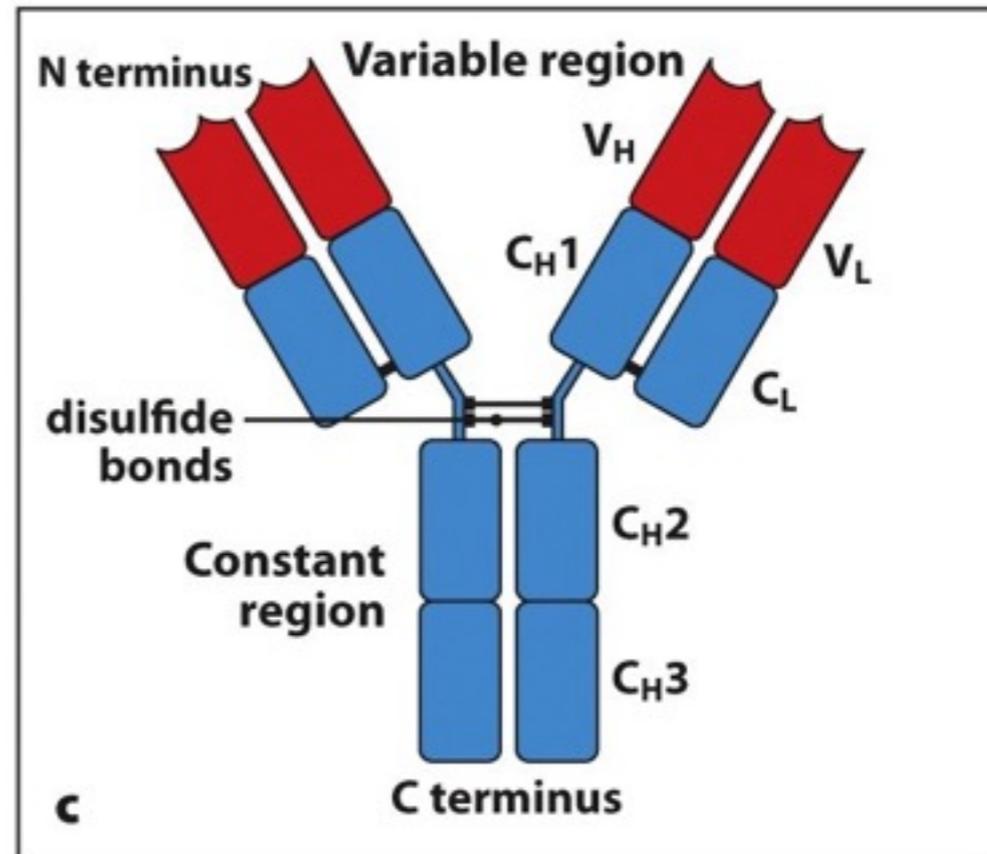
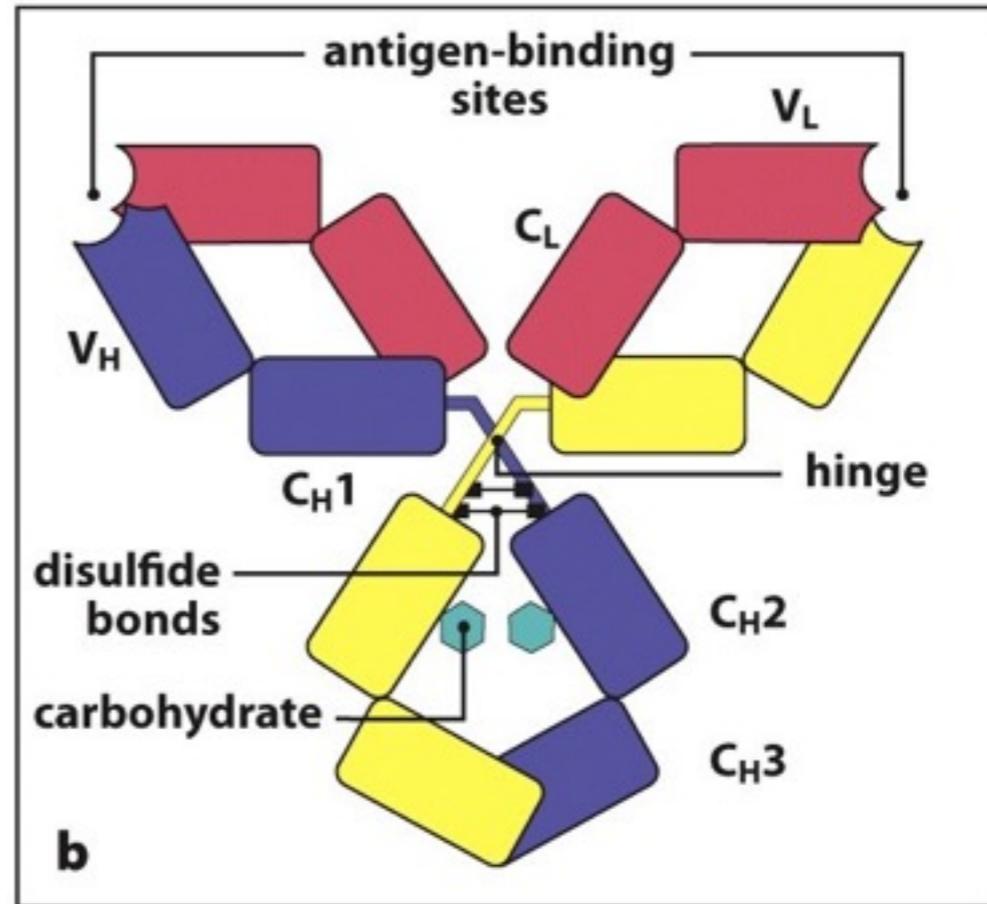
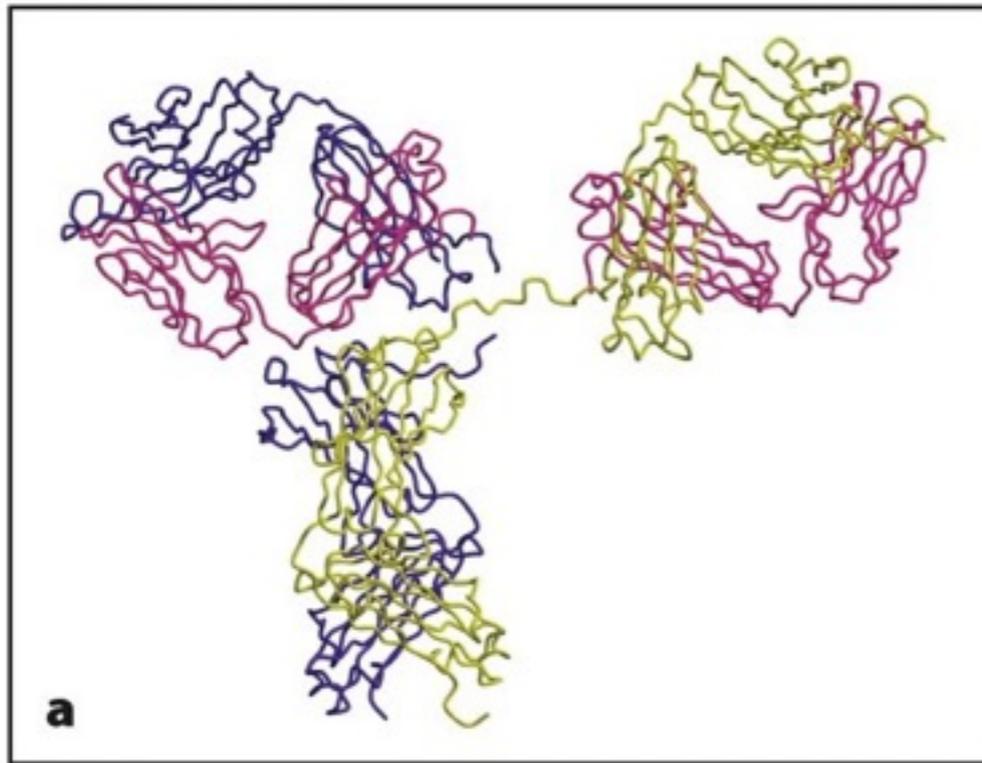


Figure 4.2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



conceito importante!

Figure 4.1 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

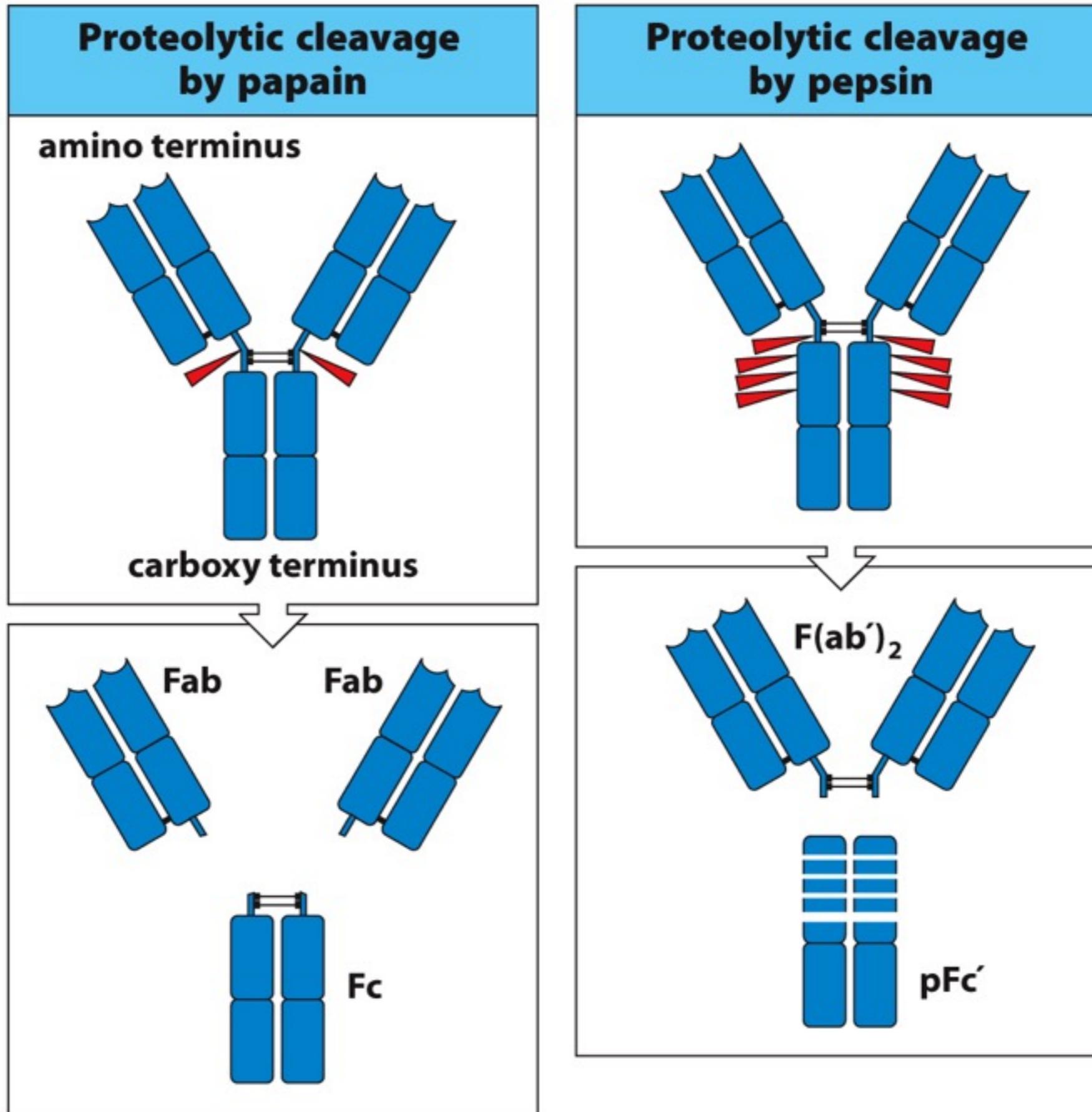


Figure 4.3 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

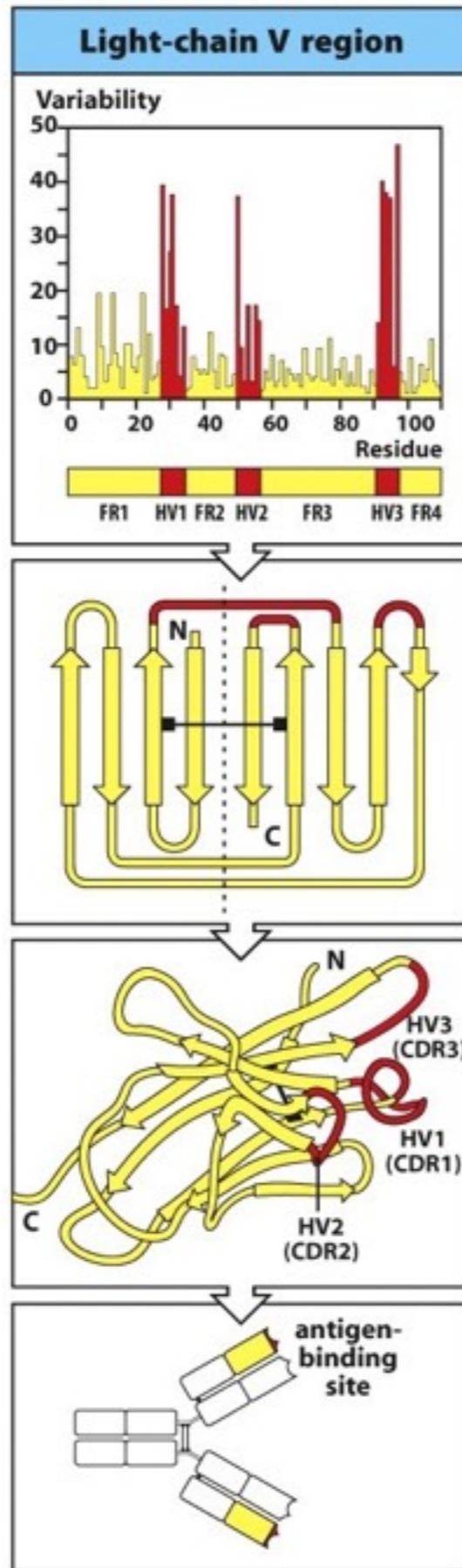


Figure 4.7 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

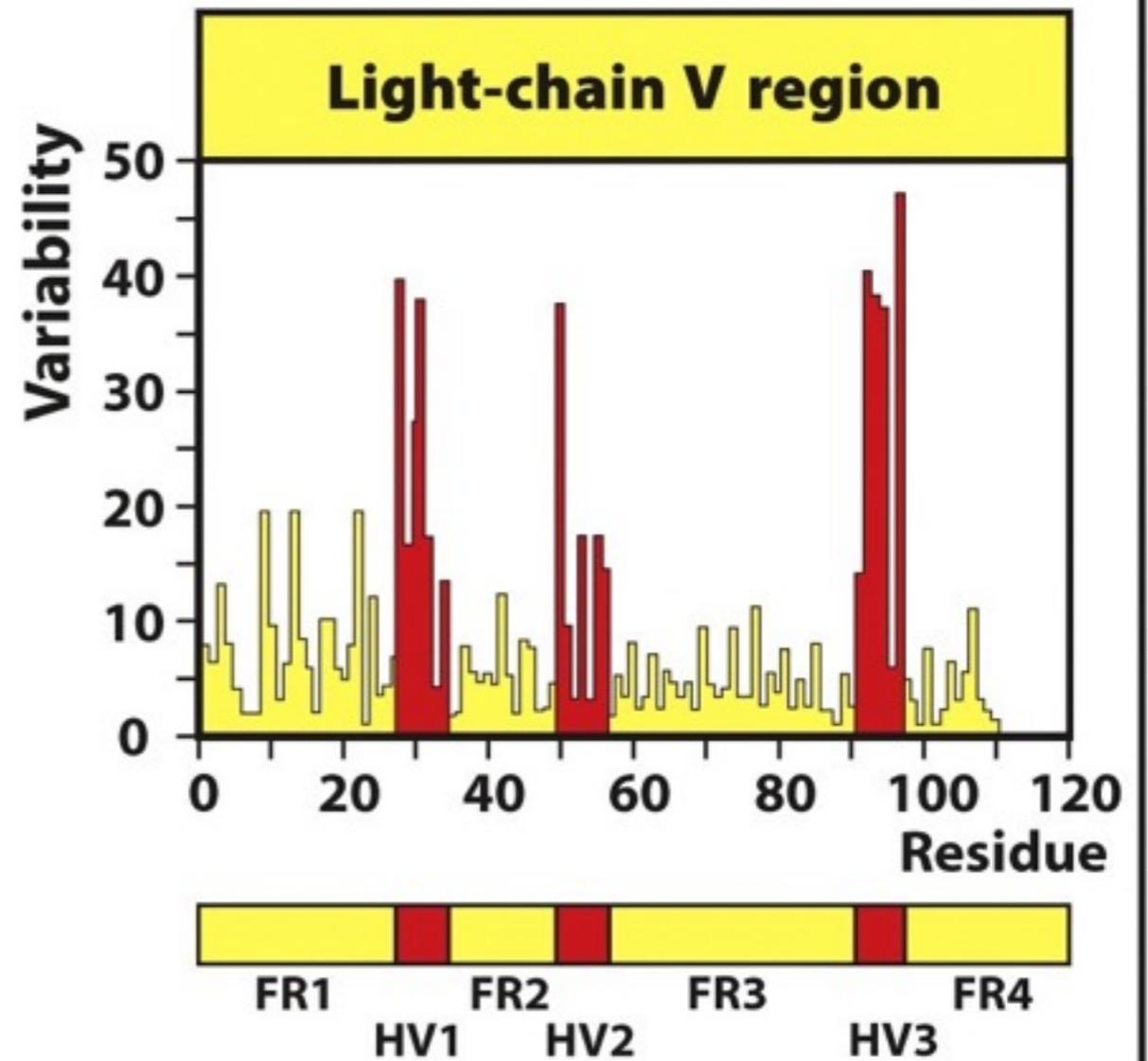
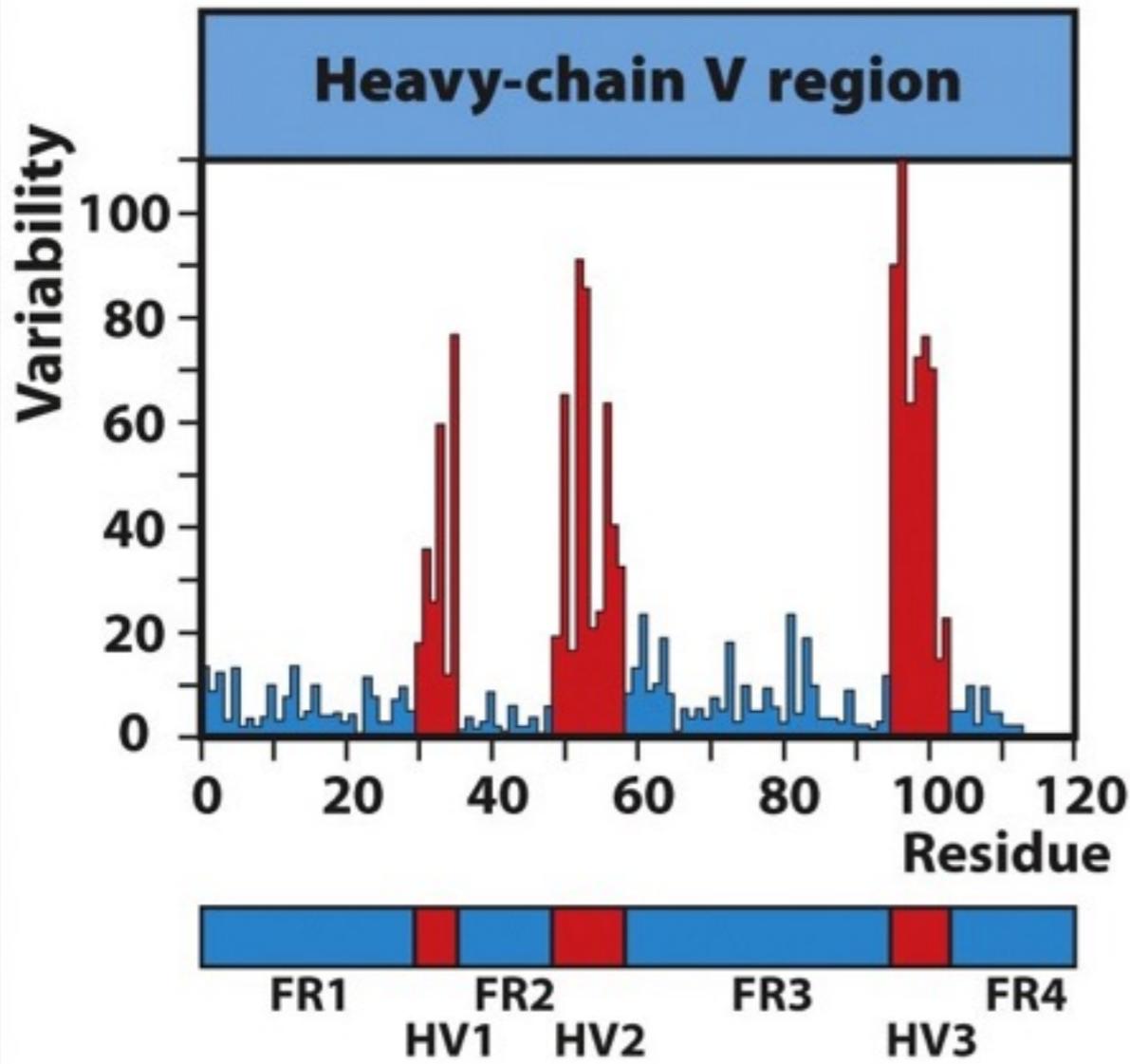
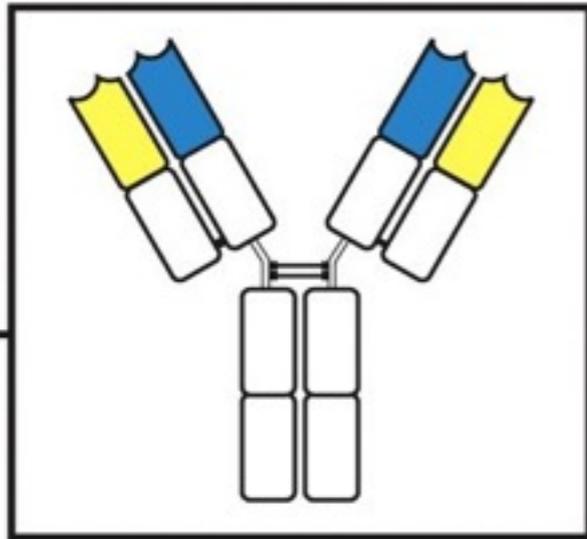


Figure 4.6 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

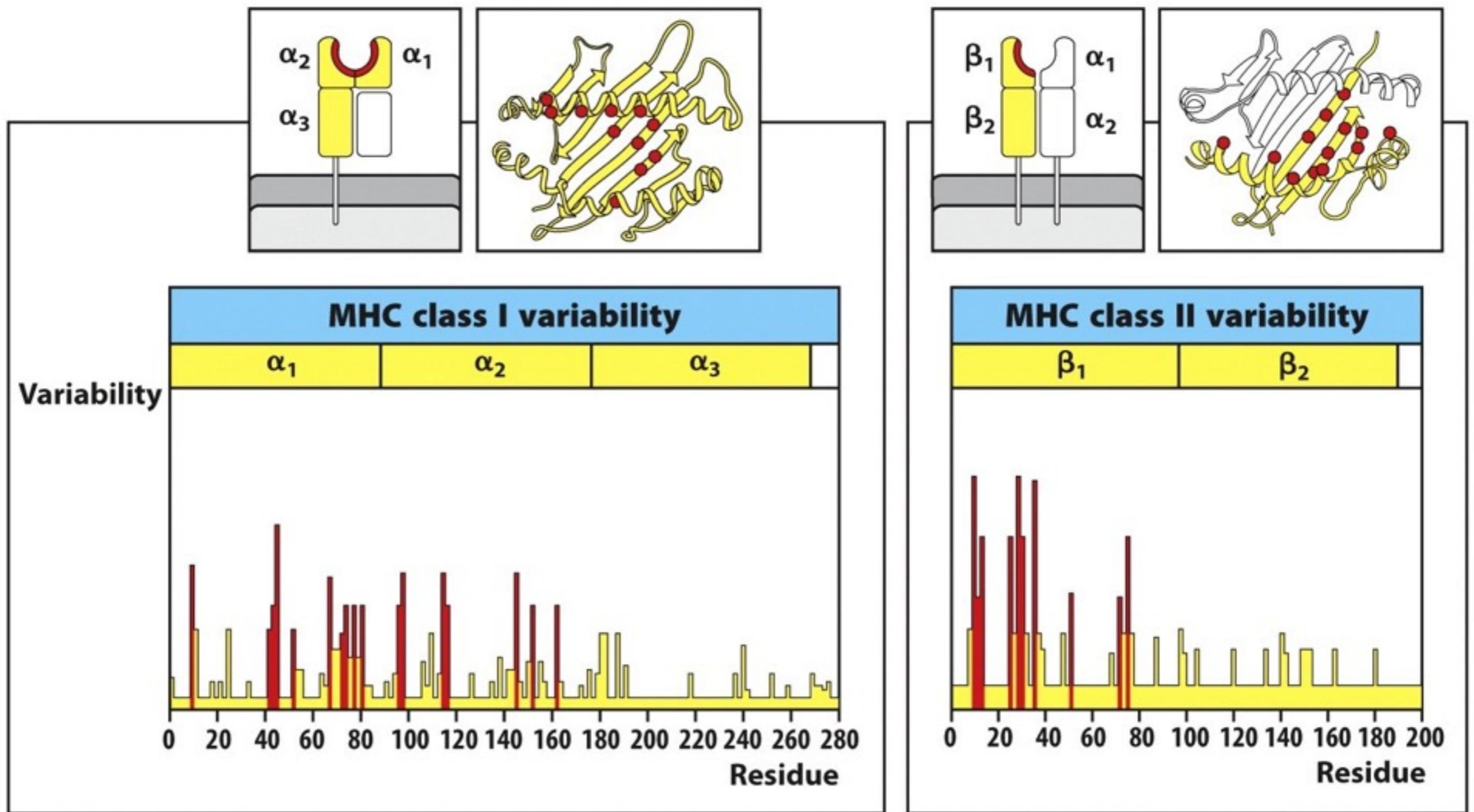
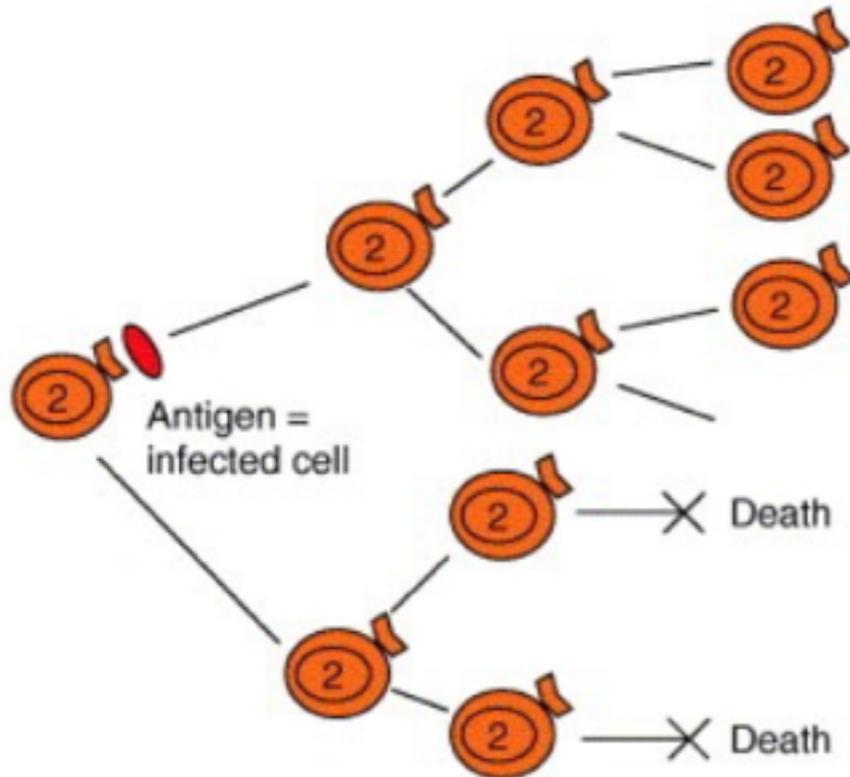


Figure 6.19 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

# Para que serve um anticorpo?

Na superfície do linfócito B:  
ativação do linfócito



Na forma solúvel:

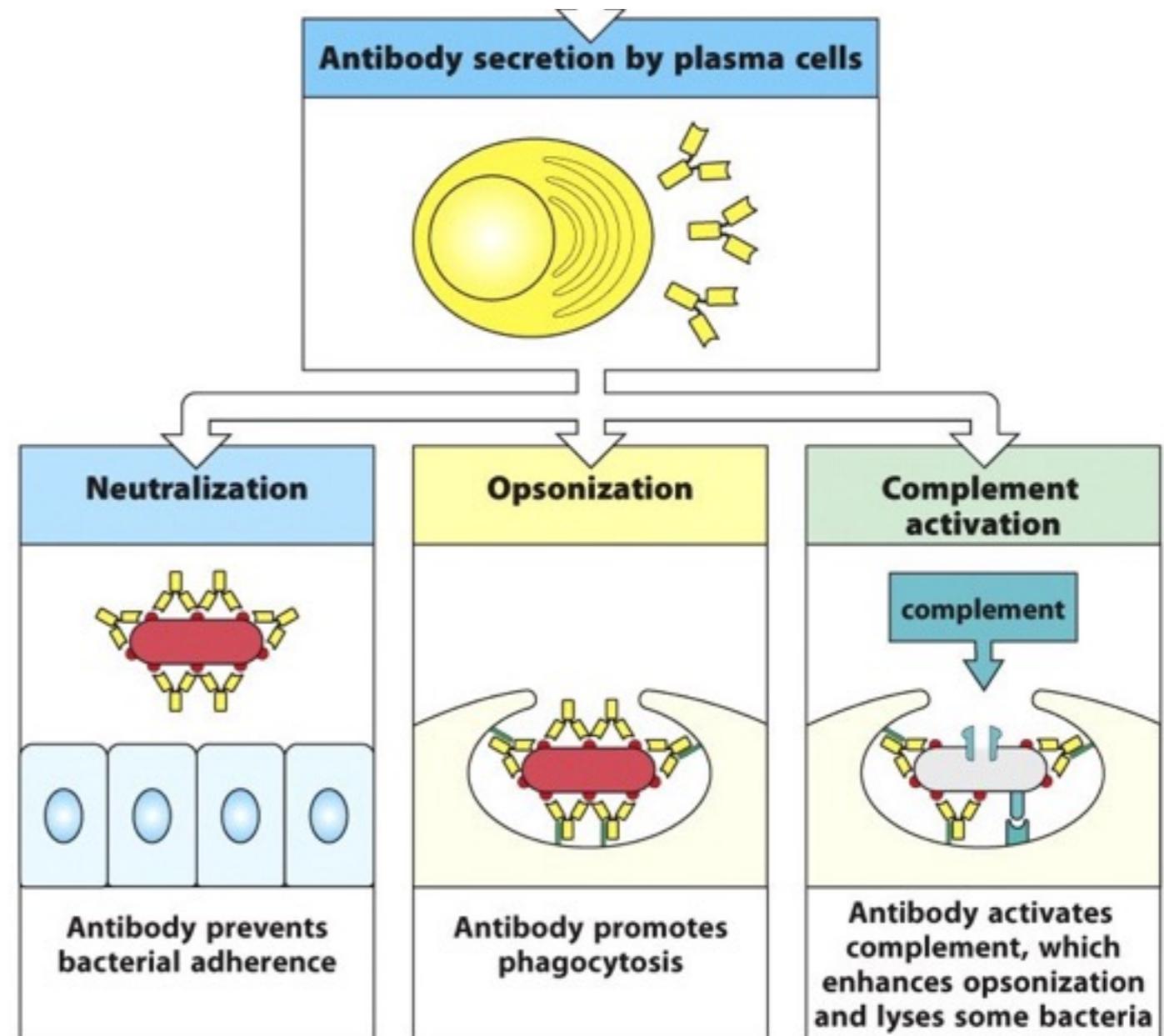


Figure 10.1 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



conceito importante!

# Neutralização

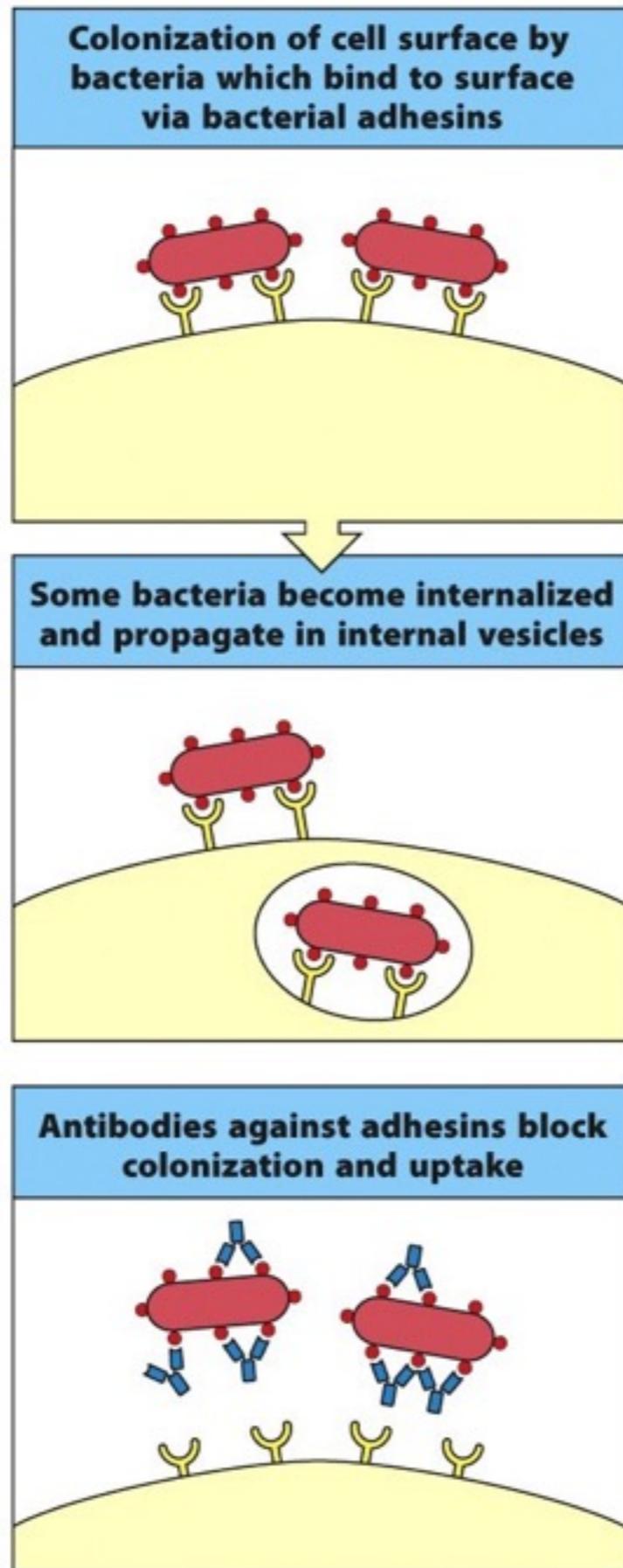


Figure 10.28 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

# Opsonização

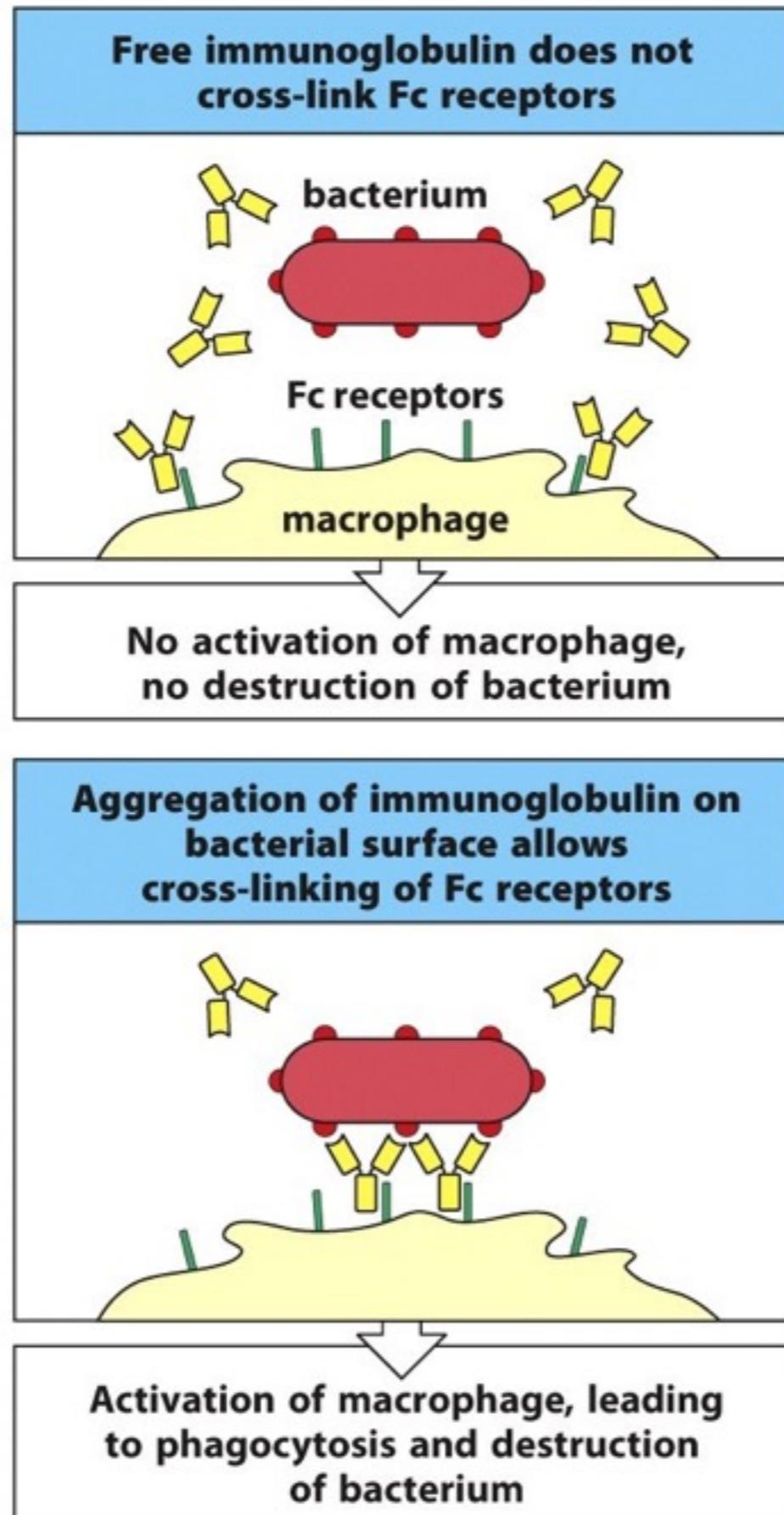


Figure 10.34 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

# ADCC

## Antibody-Dependent Cell Cytotoxicity

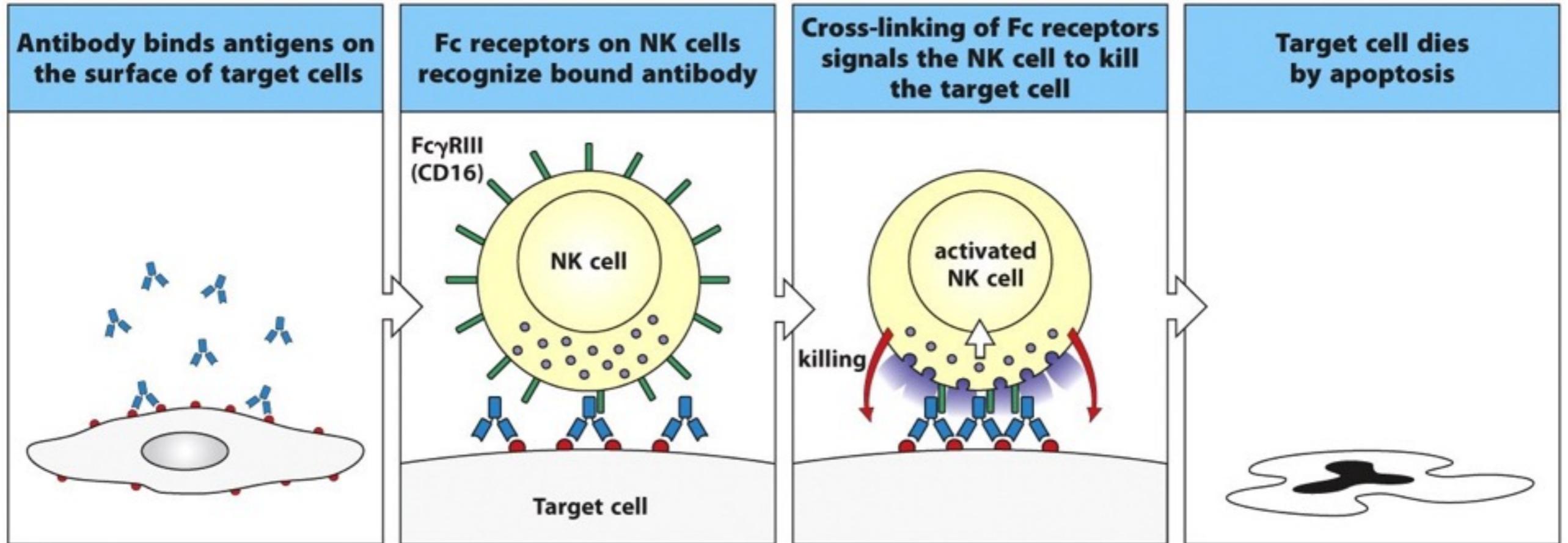
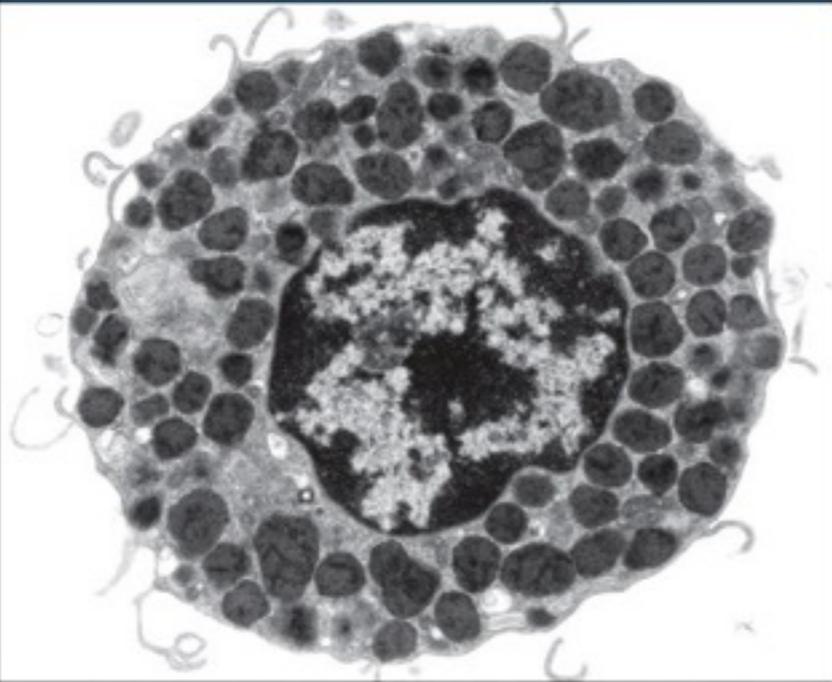


Figure 10.36 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

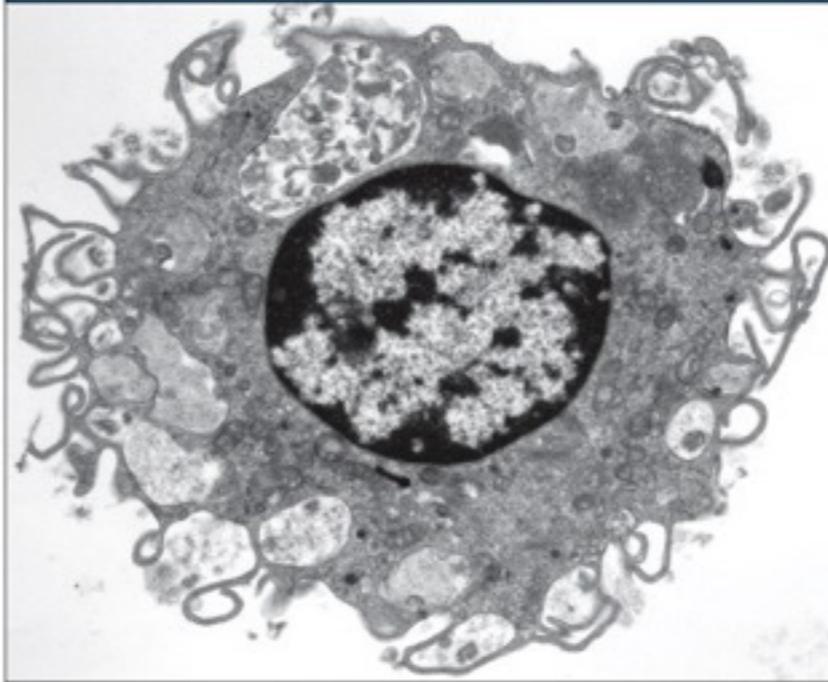


conceito importante!

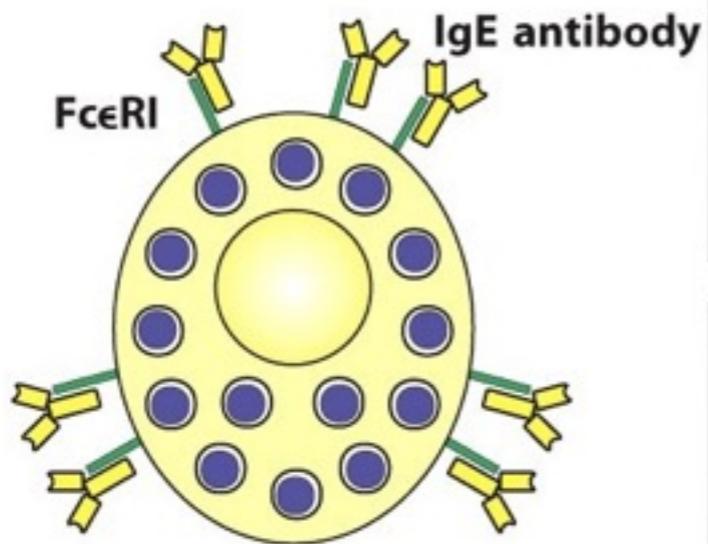
**Resting mast cell**



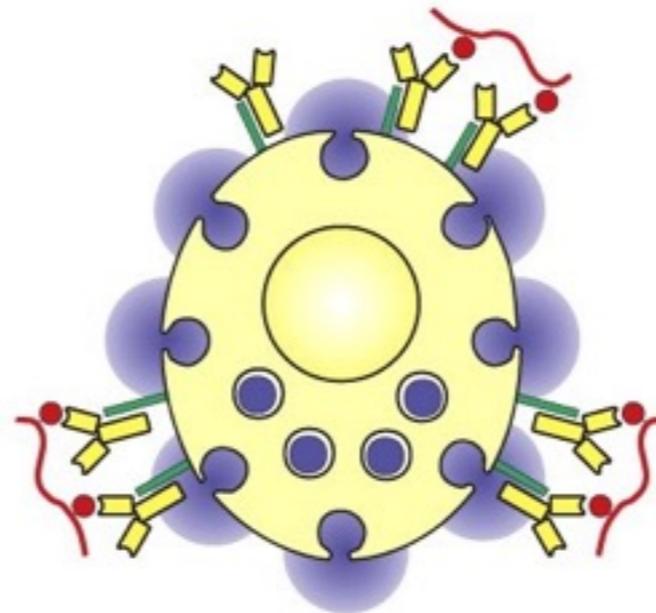
**Activated mast cell**



# Degranulação de Mastócitos



**Resting mast cell contains granules containing histamine and other inflammatory mediators**



**Multivalent antigen cross-links bound IgE antibody, causing release of granule contents**



# ISOTIPOS

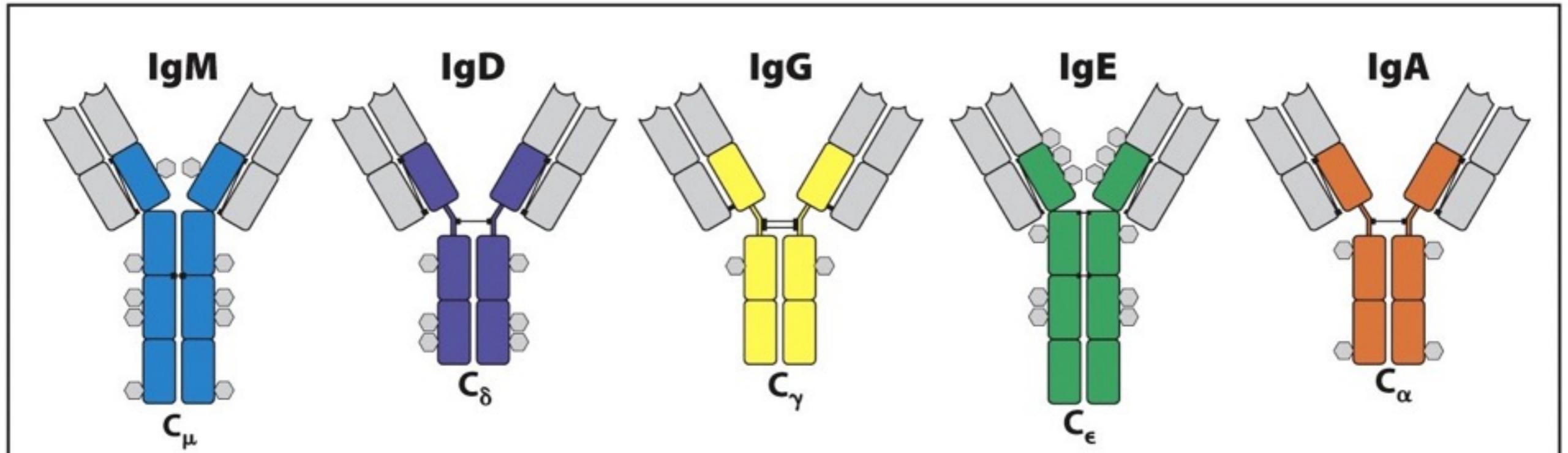


Figure 5.16 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



conceito importante!

# ISOTIPOS

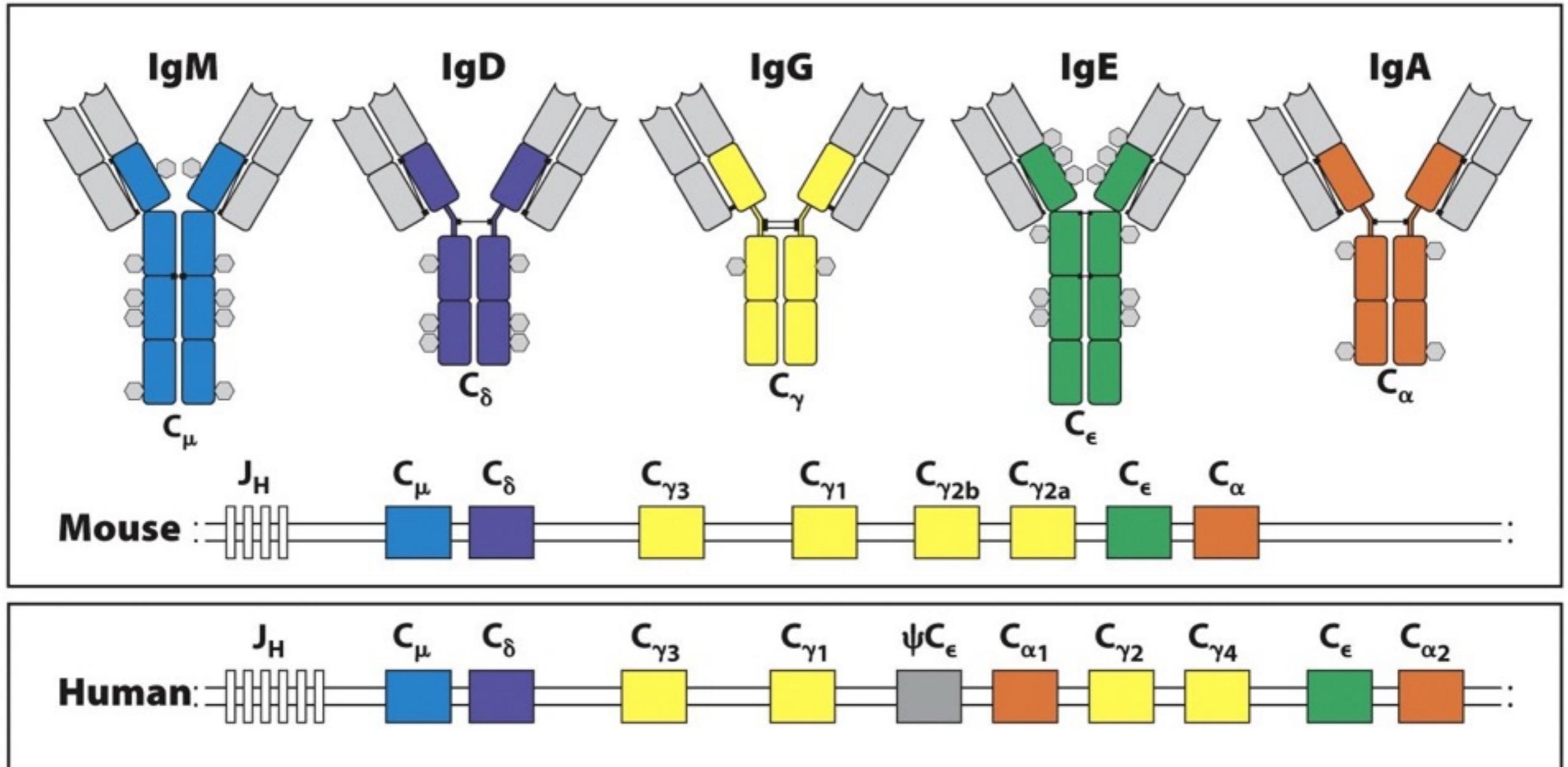
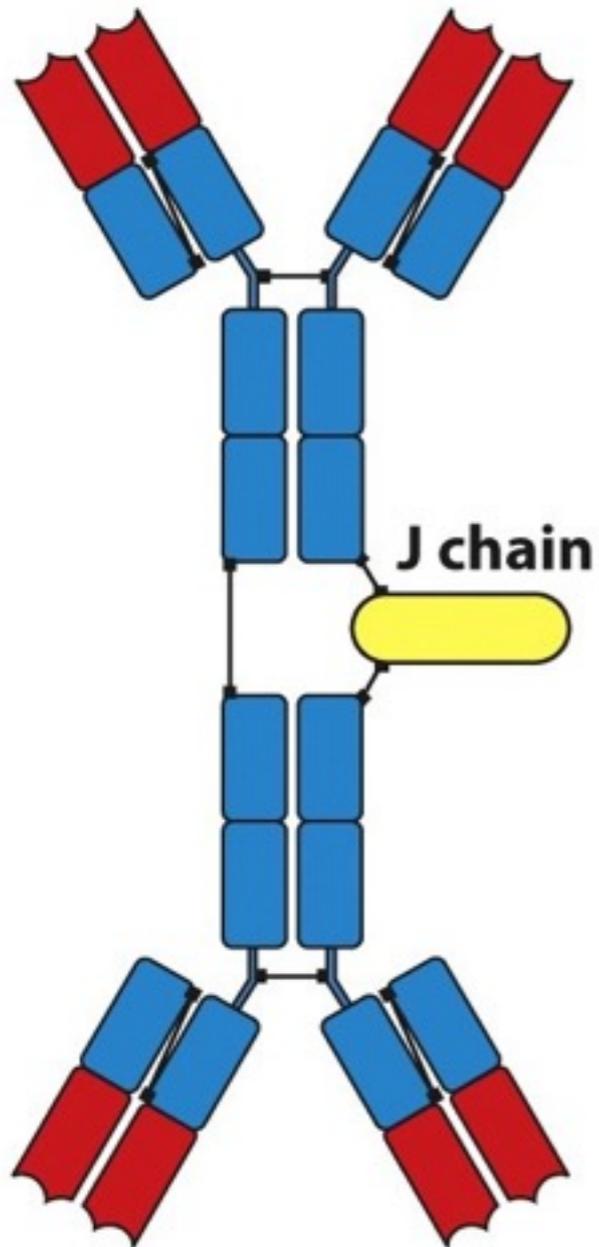


Figure 5.16 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

## Dimeric IgA



## Pentameric IgM

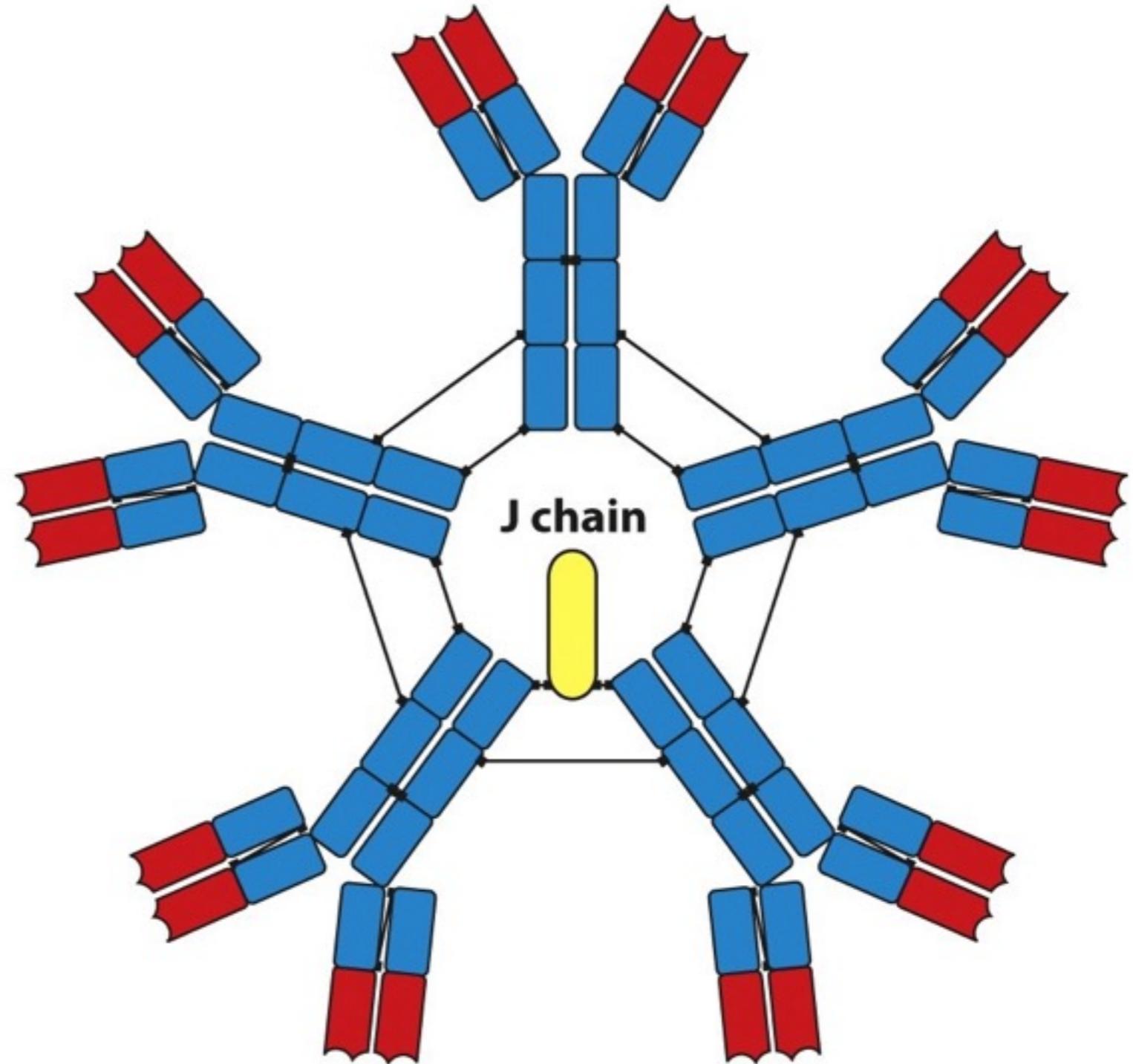
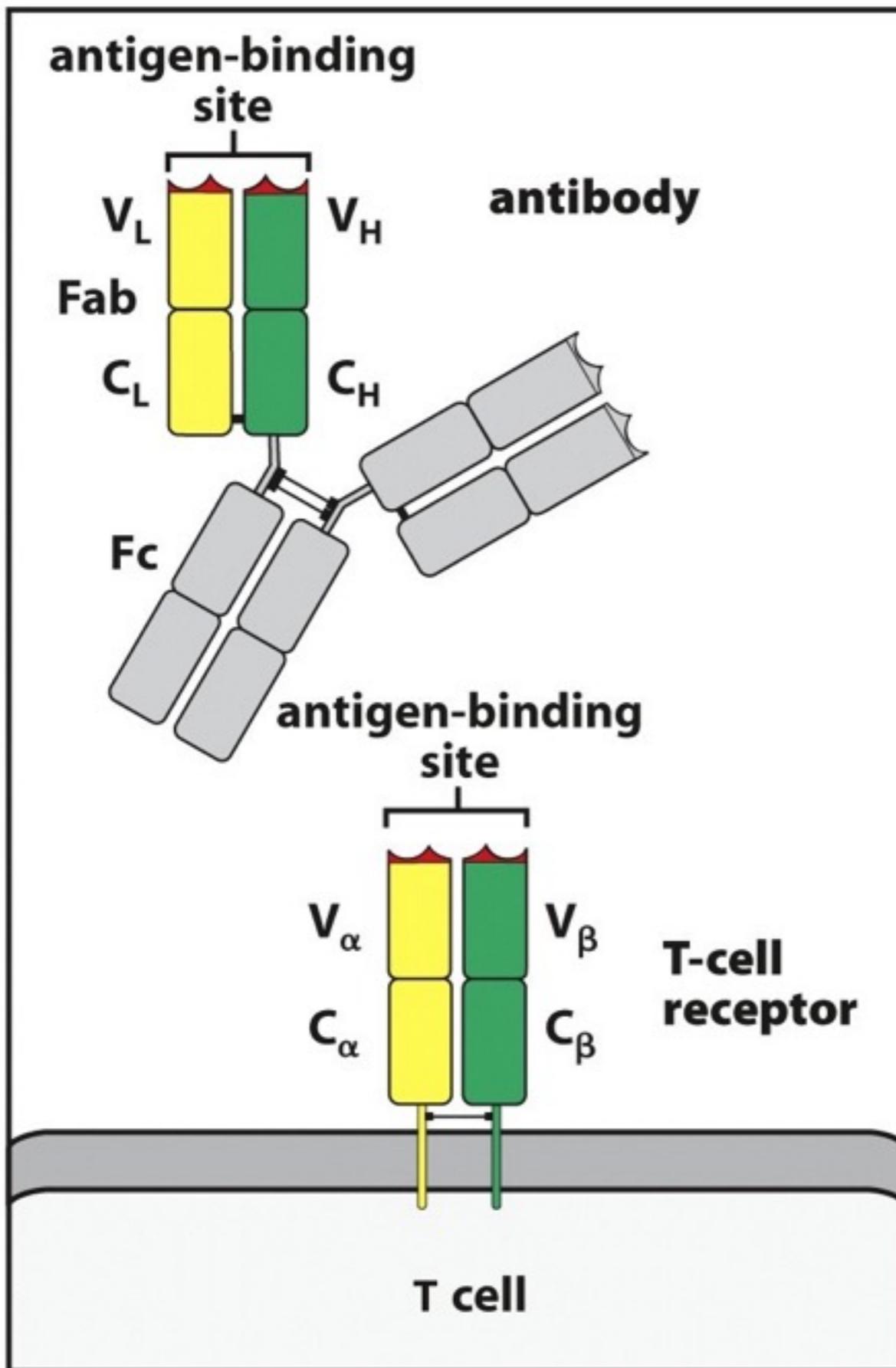


Figure 5.19 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

	Immunoglobulin								
	IgG1	IgG2	IgG3	IgG4	IgM	IgA1	IgA2	IgD	IgE
Heavy chain	$\gamma_1$	$\gamma_2$	$\gamma_3$	$\gamma_4$	$\mu$	$\alpha_1$	$\alpha_2$	$\delta$	$\epsilon$
Molecular weight (kDa)	146	146	165	146	970	160	160	184	188
Serum level (mean adult mg/ml)	9	3	1	0.5	1.5	3.0	0.5	0.03	$5 \times 10^{-5}$
Half-life in serum (days)	21	20	7	21	10	6	6	3	2
Classical pathway of complement activation	++	+	+++	-	++++	-	-	-	-
Alternative pathway of complement activation	-	-	-	-	-	+	-	-	-
Placental transfer	+++	+	++	-/+	-	-	-	-	-
Binding to macrophage and phagocyte Fc receptors	+	-	+	-/+	-	+	+	-	+
High-affinity binding to mast cells and basophils	-	-	-	-	-	-	-	-	+++
Reactivity with staphylococcal Protein A	+	+	-/+	+	-	-	-	-	-

Figure 5.15 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



Para que serve um TCR?

T  
Cell  
Receptor

SEMPRE na superfície do linfócito T:  
ativação do linfócito



conceito importante!

Figure 4.11 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

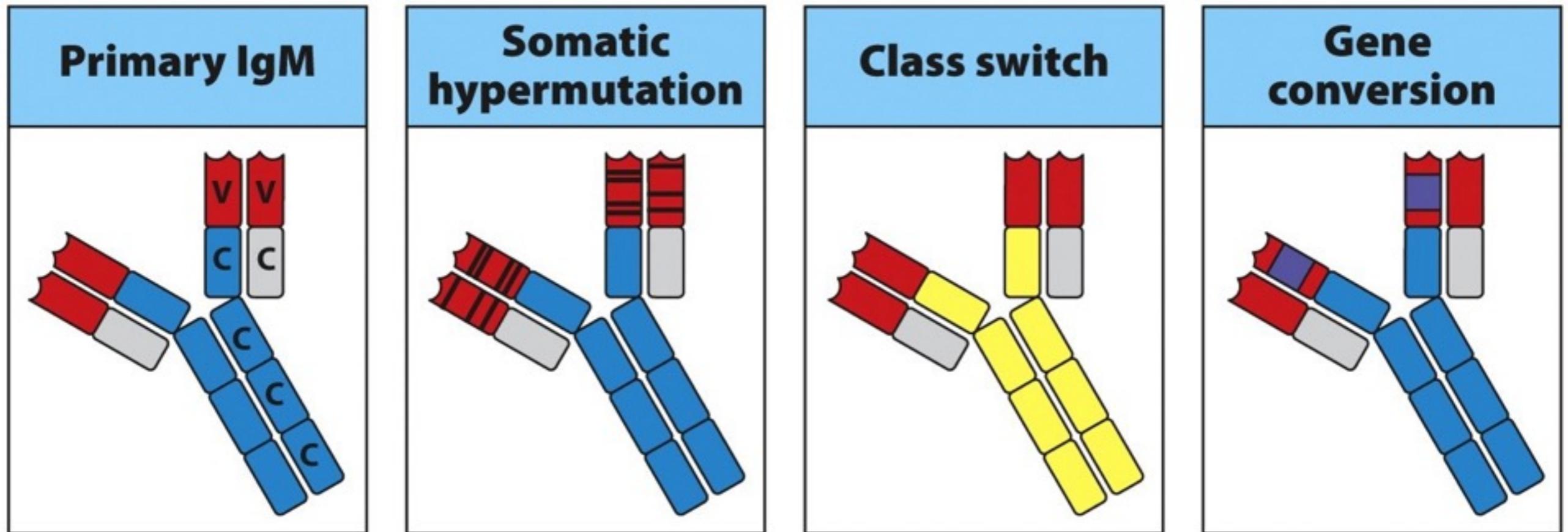


Figure 5.20 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

## Mecanismos geradores de diversidade nos receptores BCR e TCR:

- \* recombinação V(D)J → T e B
  - \* diversidade funcional
  - \* adição aleatória de bases
- \* hipermutação somática (maturação de afinidade)  
→ somente B
- \* troca de classe ou isotipo → somente B
- \* conversão fênica → somente B



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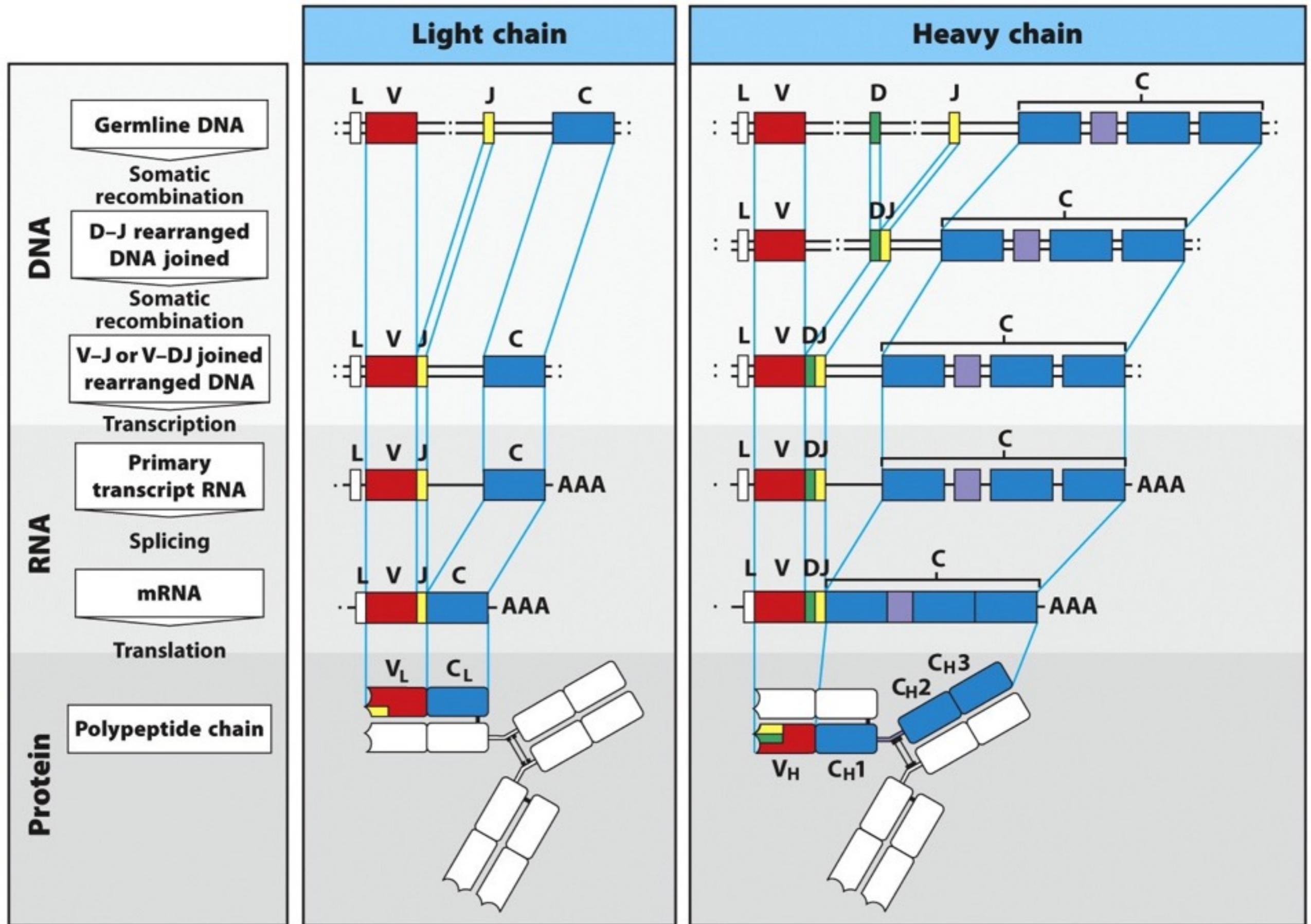


Figure 5.1 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

Immunology wars: A billion antibodies  
Nature Videos

**<https://youtu.be/Na-Zc-xWCLE>**

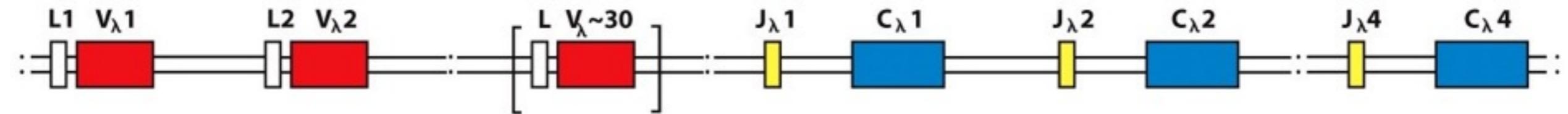
## Number of functional gene segments in human immunoglobulin loci

Segment	Light chains		Heavy chain
	$\kappa$	$\lambda$	H
Variable (V)	34–38	29–33	38–46
Diversity (D)	0	0	23
Joining (J)	5	4–5	6
Constant (C)	1	4–5	9

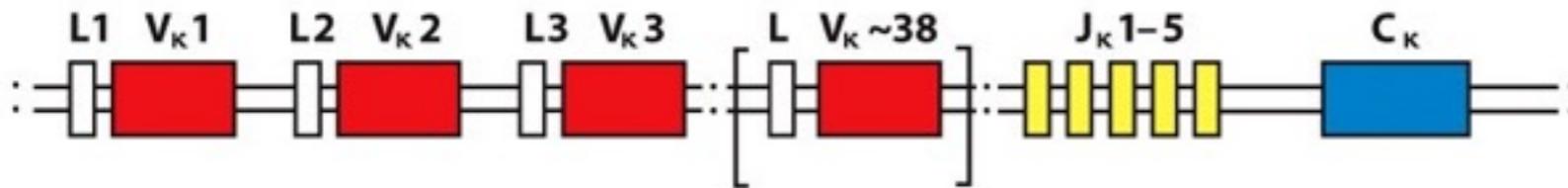
Figure 5.2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

# BCR

## $\lambda$ light-chain locus



## $\kappa$ light-chain locus



## Heavy-chain locus



Figure 5.3 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

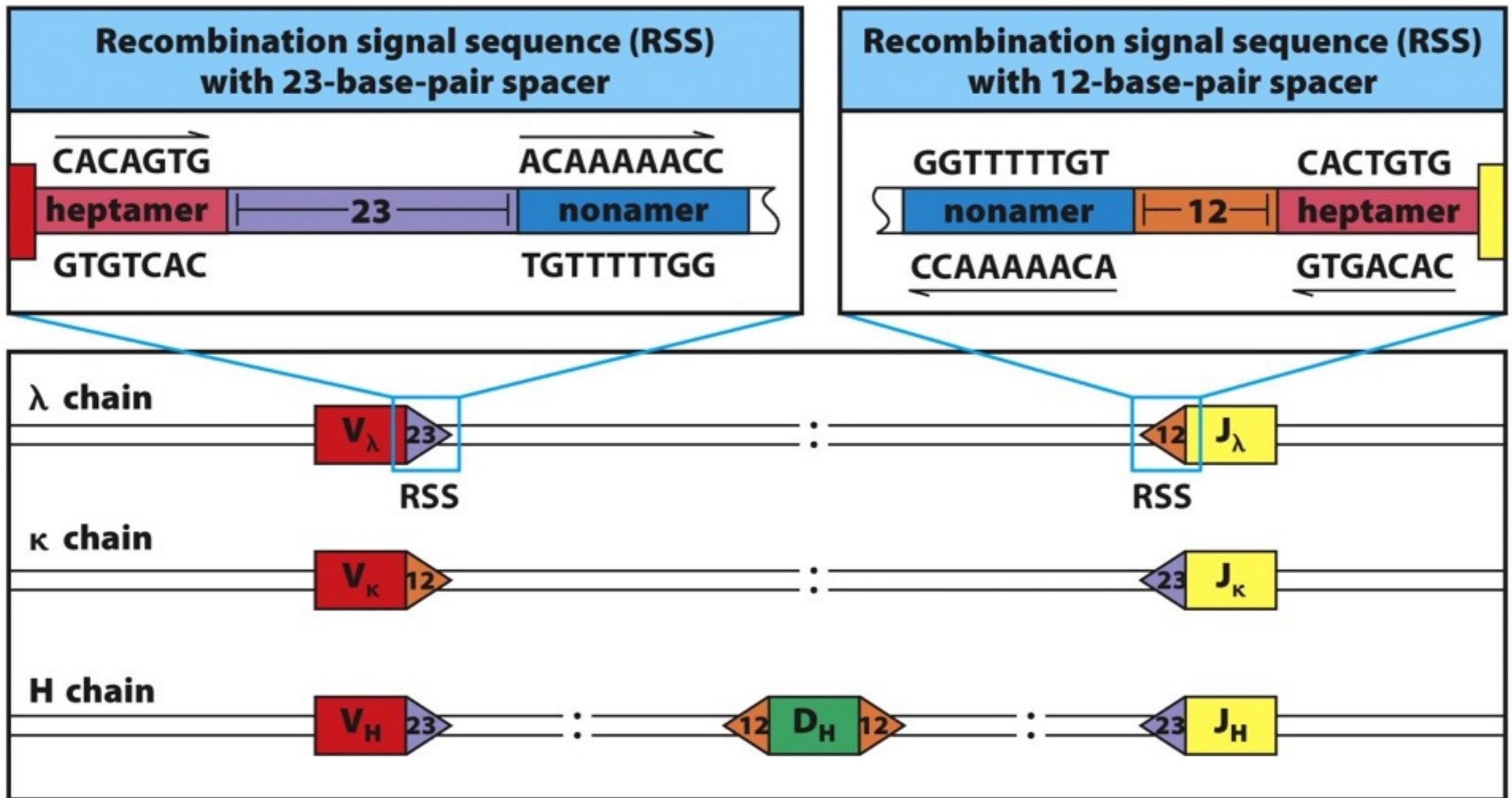


Figure 5.4 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

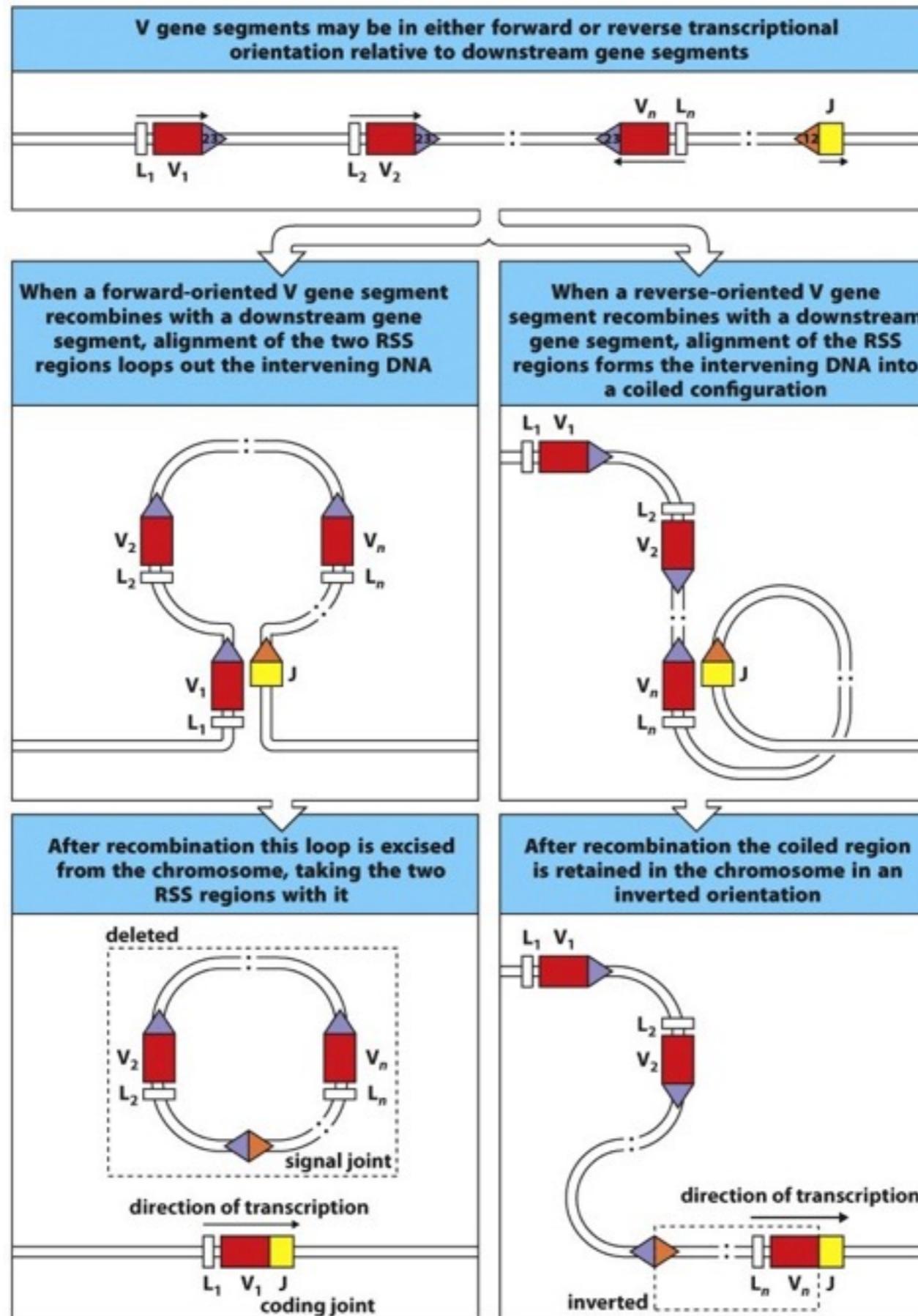


Figure 5.5 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

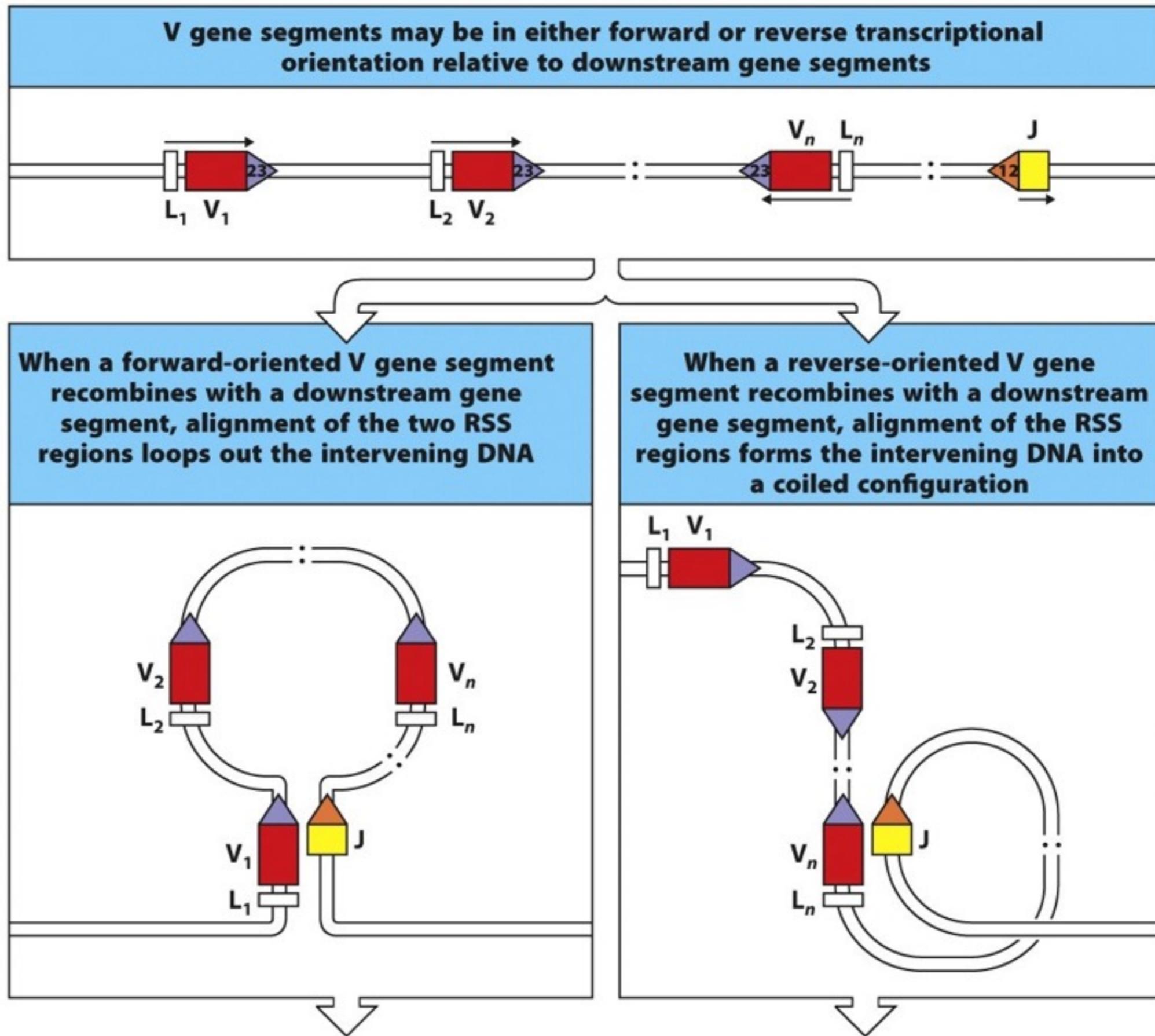


Figure 5.5 part 1 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

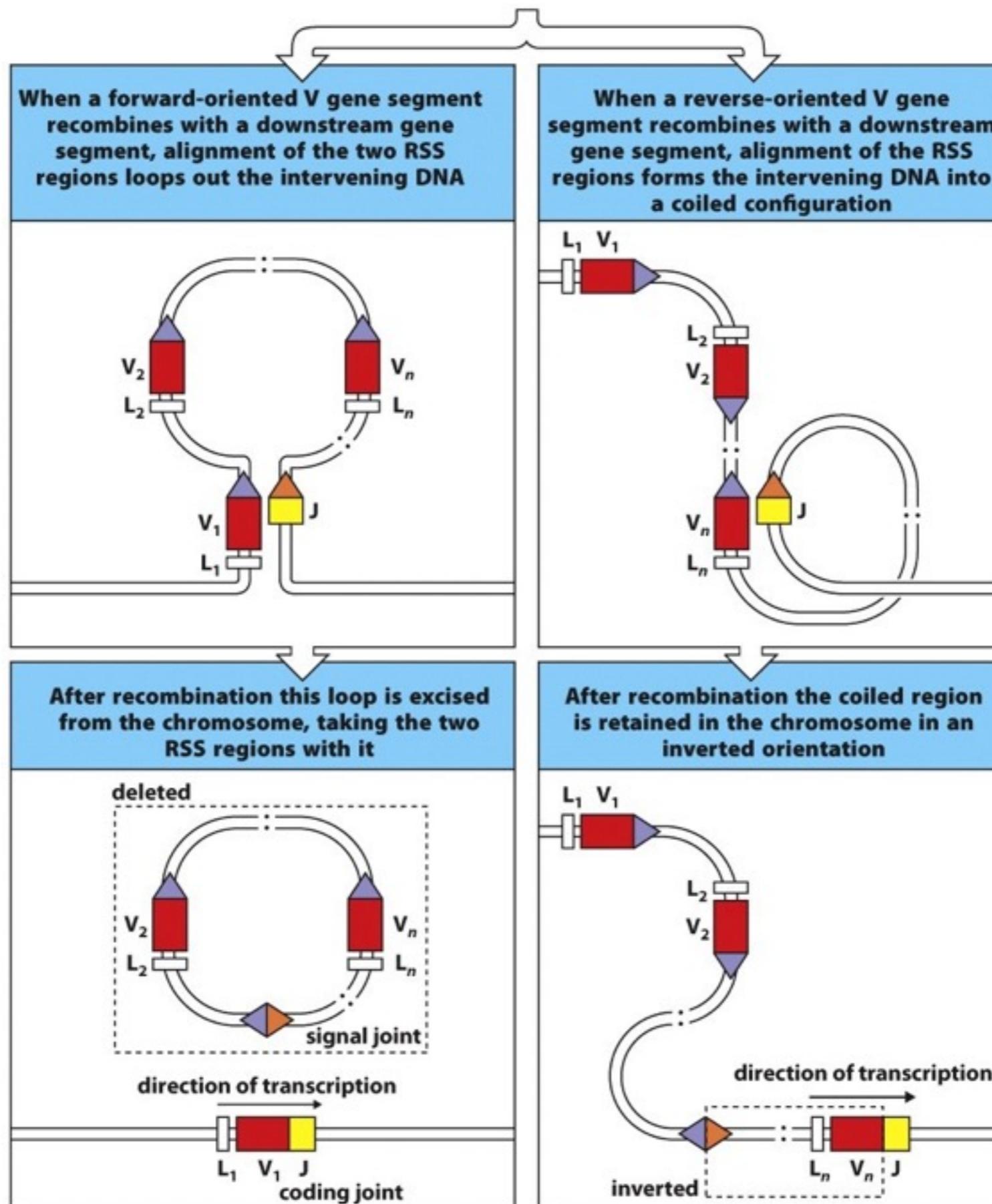


Figure 5.5 part 2 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

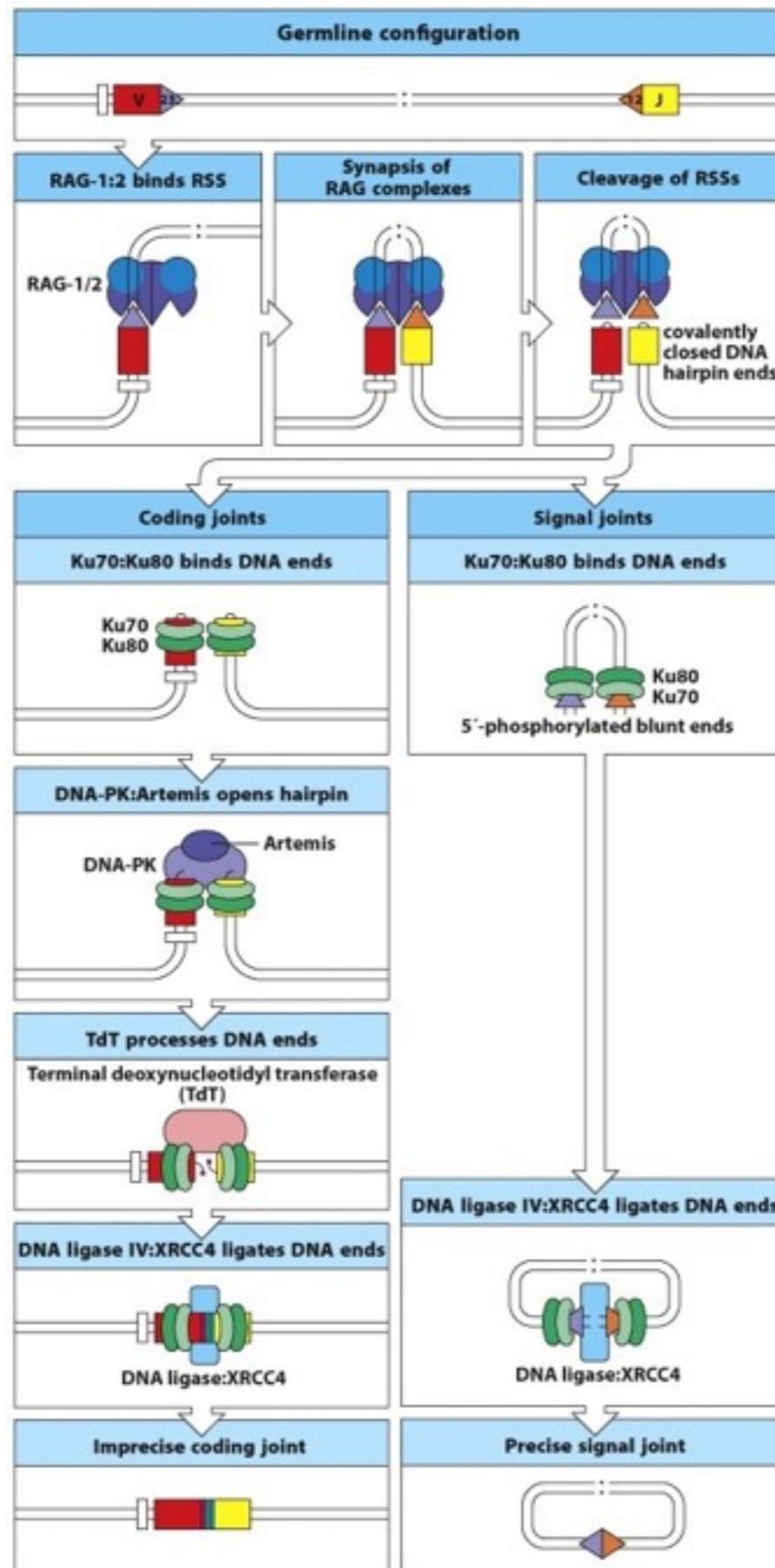


Figure 5.6 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

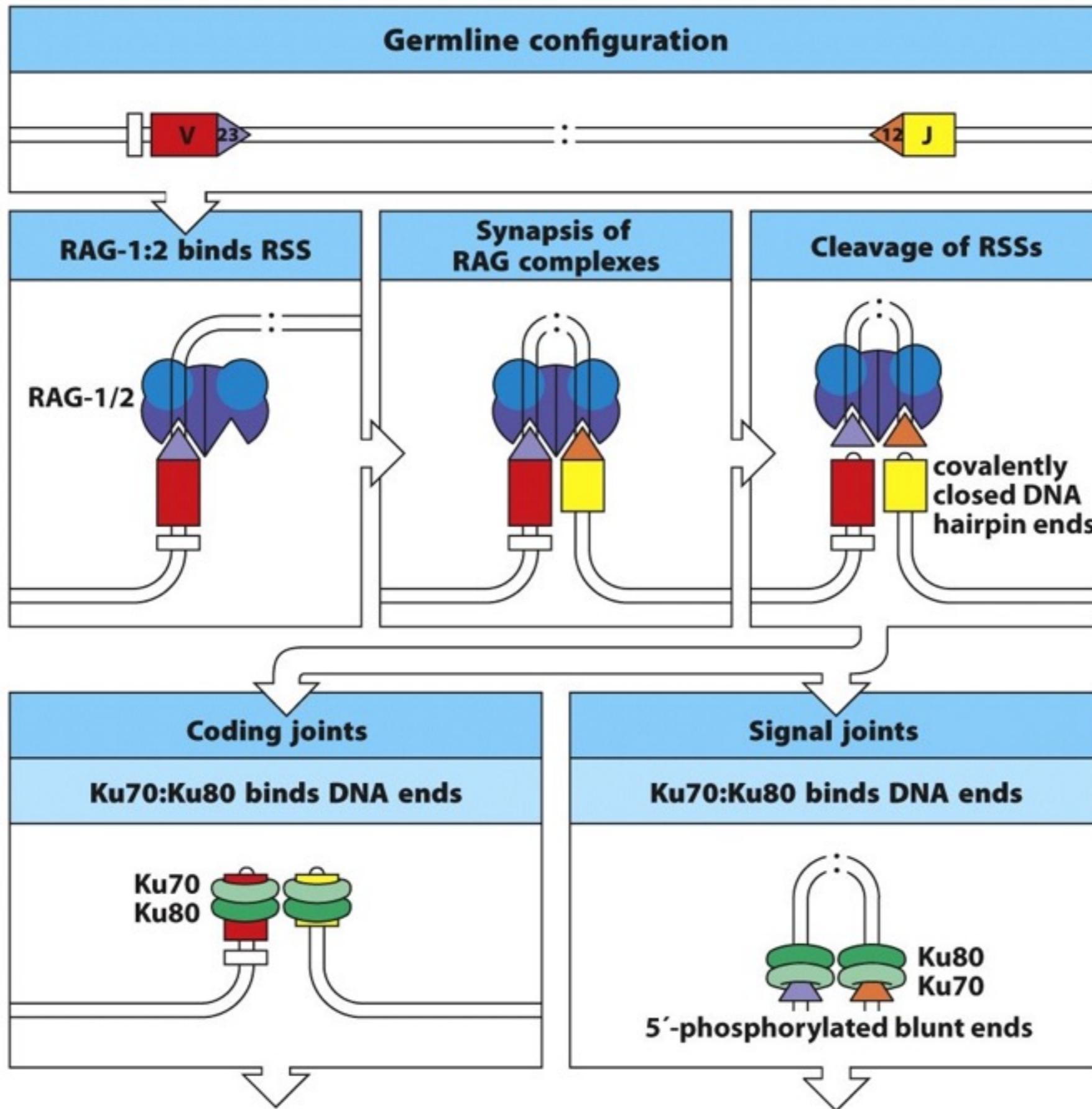


Figure 5.6 part 1 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

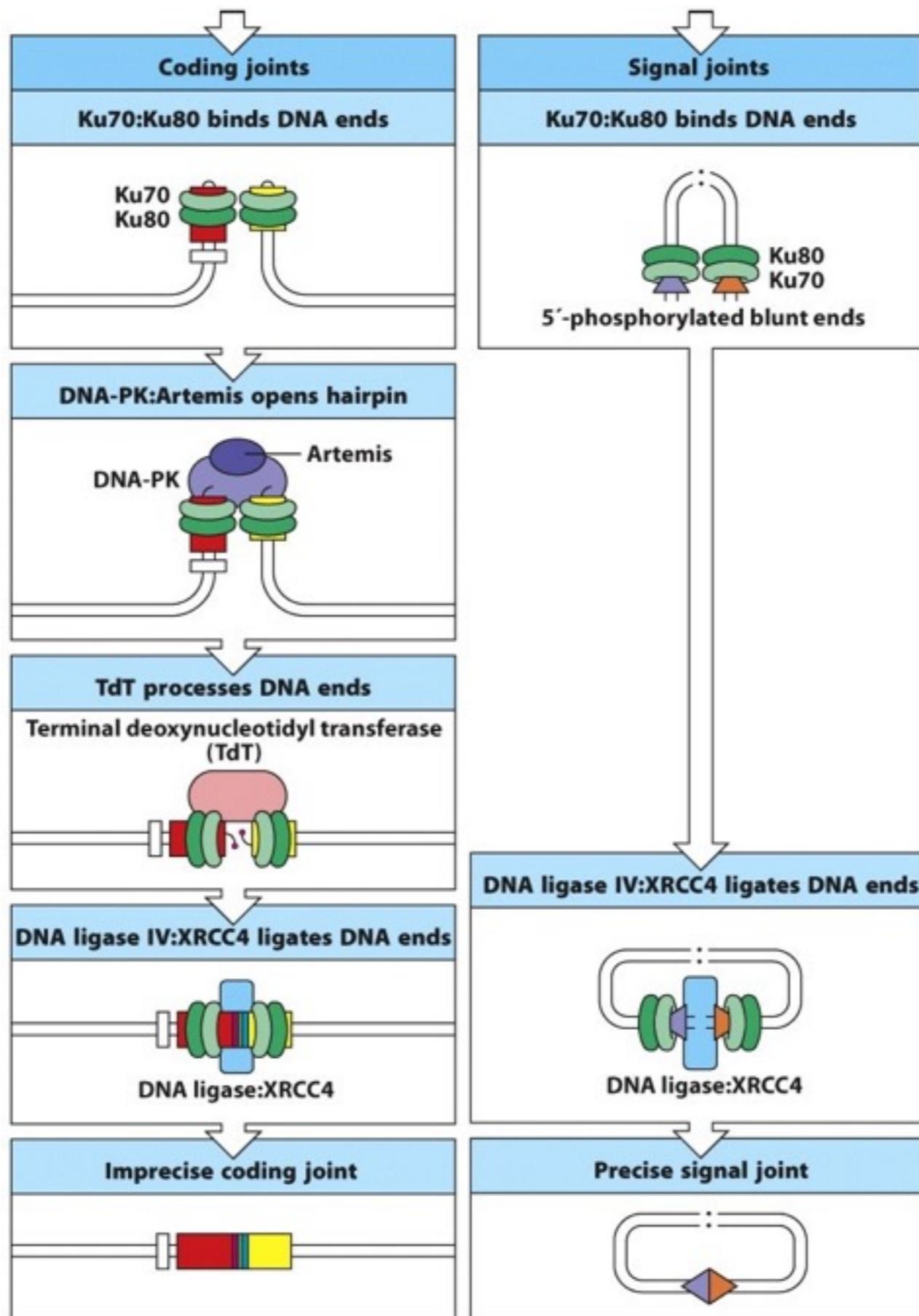


Figure 5.6 part 2 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

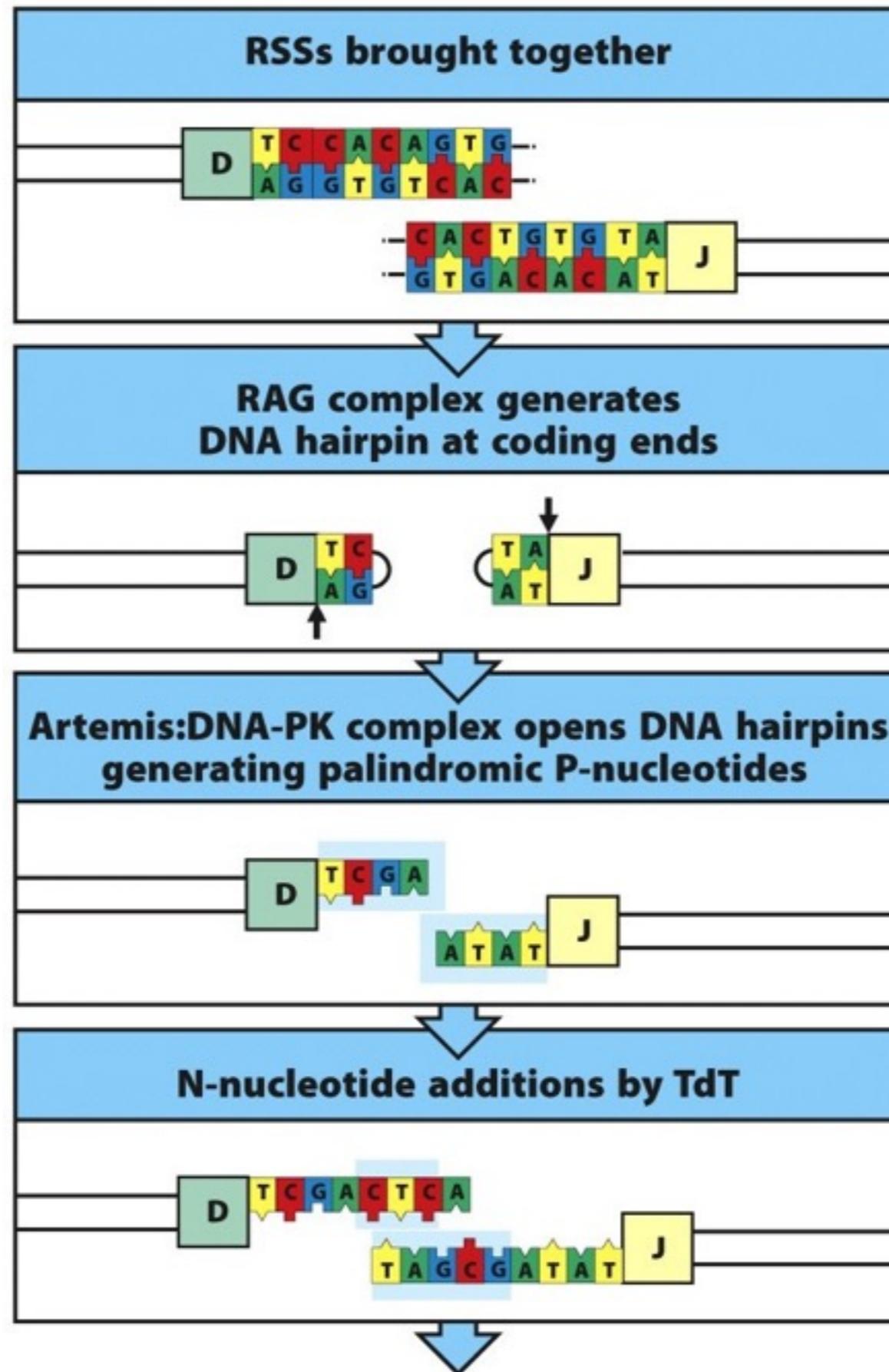


Figure 5.7 part 1 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

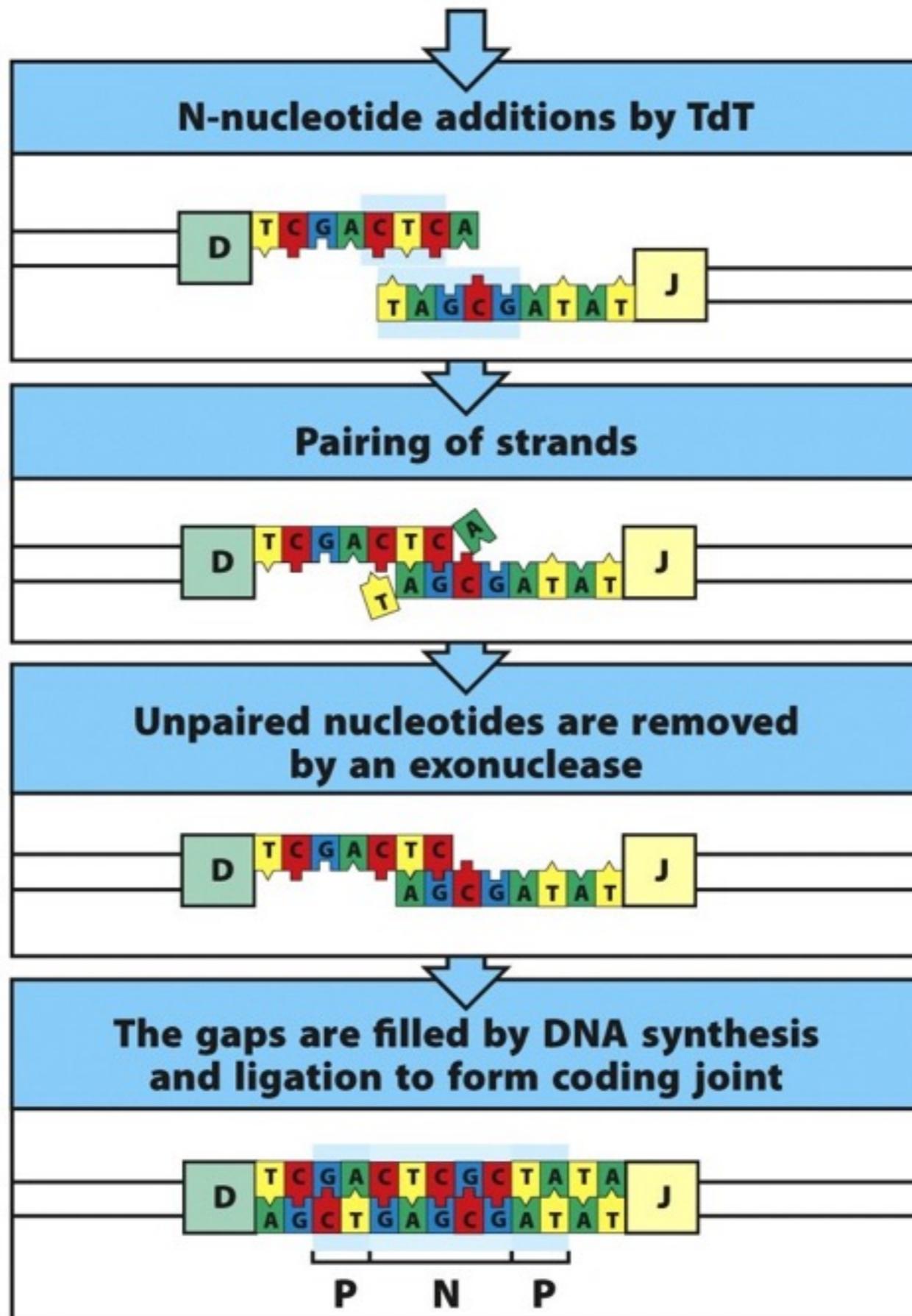


Figure 5.7 part 2 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

# TCR

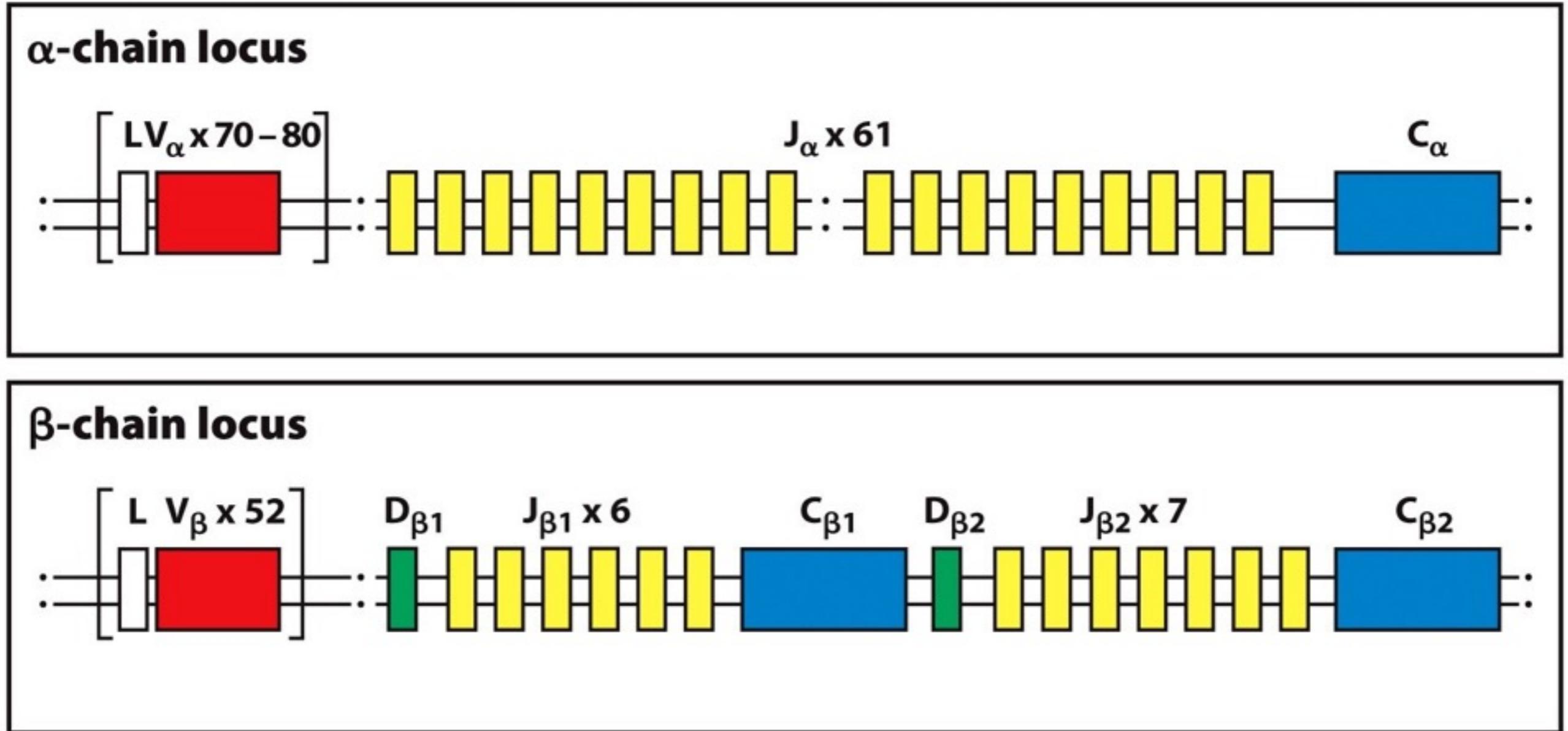


Figure 5.8 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

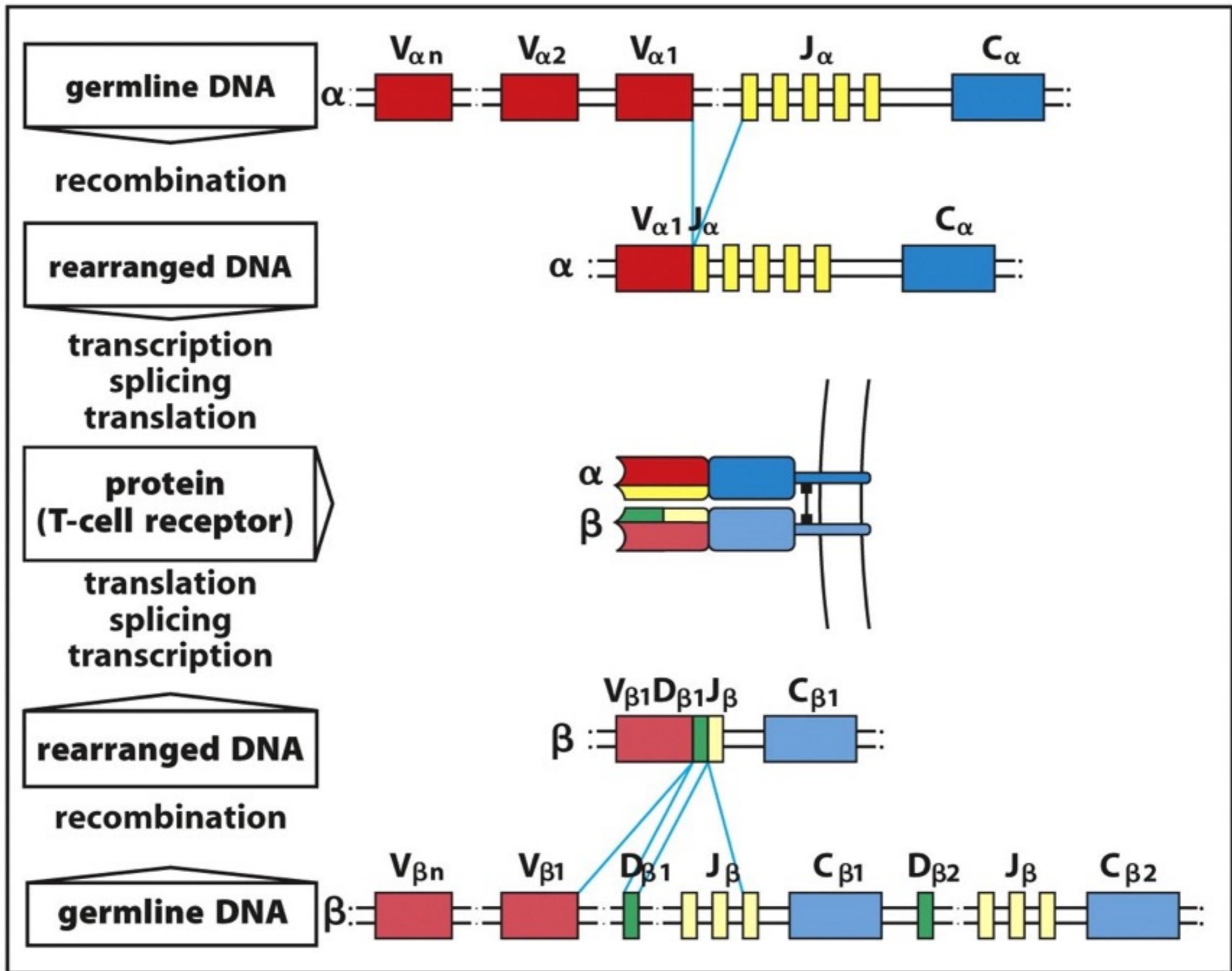


Figure 5.9 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

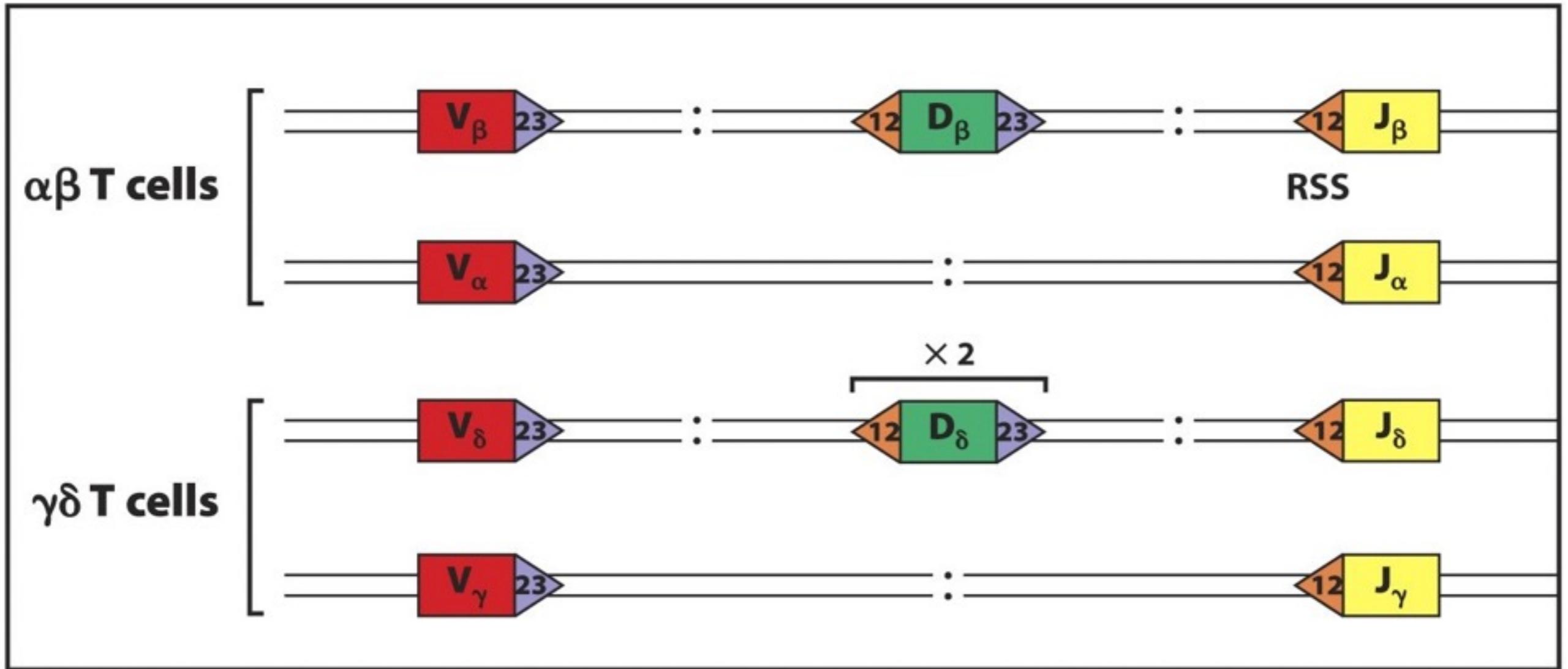


Figure 5.10 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

Element	Immunoglobulin		$\alpha:\beta$ T-cell receptors	
	H	$\kappa+\lambda$	$\beta$	$\alpha$
Variable segments (V)	~40	~70	52	~70
Diversity segments (D)	23	0	2	0
D segments read in three frames	rarely	–	often	–
Joining segments (J)	6	5( $\kappa$ ) 4( $\lambda$ )	13	61
Joints with N- and P-nucleotides	2	50% of joints	2	1
Number of V gene pairs	$1.9 \times 10^6$		$5.8 \times 10^6$	
Junctional diversity	$\sim 3 \times 10^7$		$\sim 2 \times 10^{11}$	
Total diversity	$\sim 5 \times 10^{13}$		$\sim 10^{18}$	

Figure 5.11 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

splicing alternativo gera a forma secretada da IgM

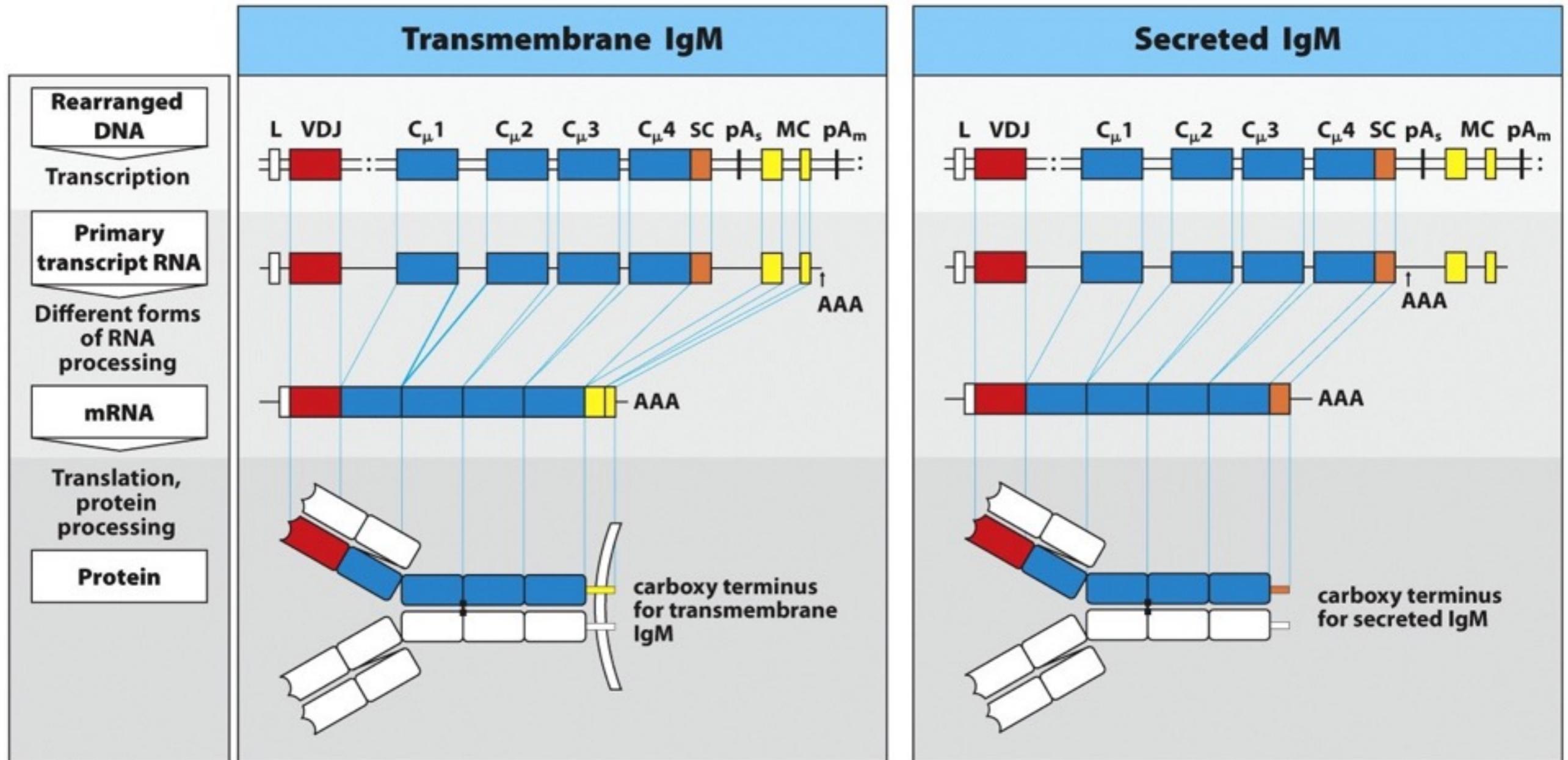


Figure 5.18 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

splicing alternativo gera a IgD (também transmembrana)

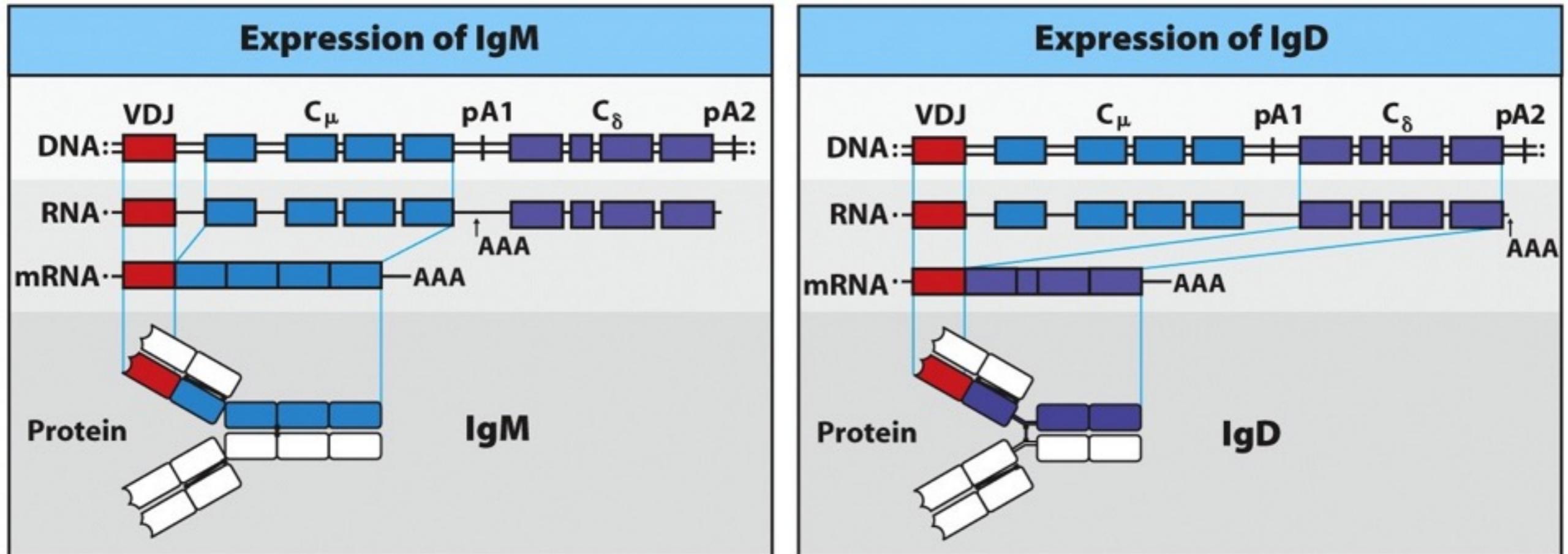


Figure 5.17 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

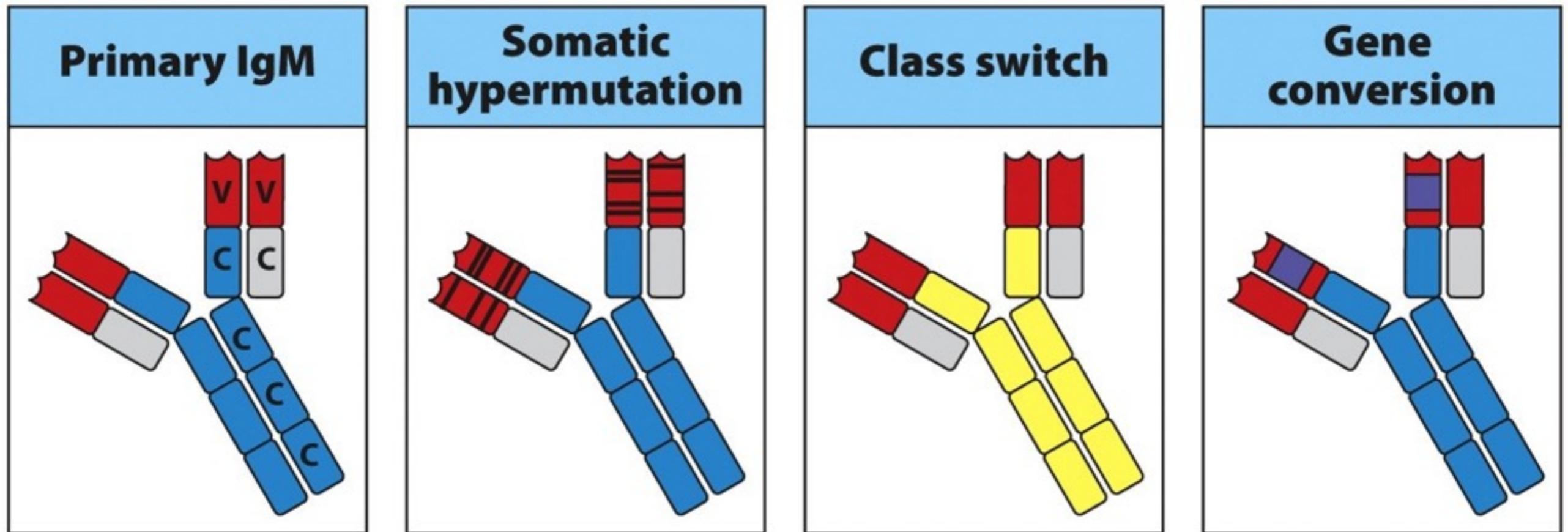


Figure 5.20 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

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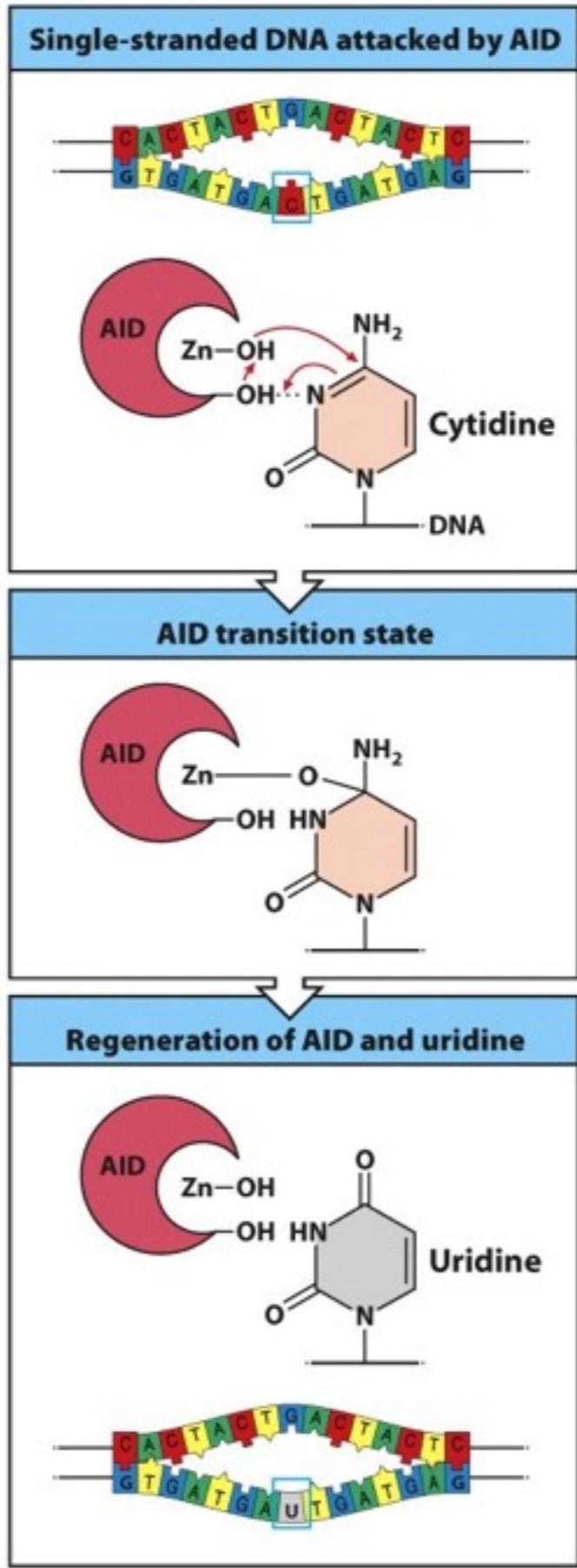
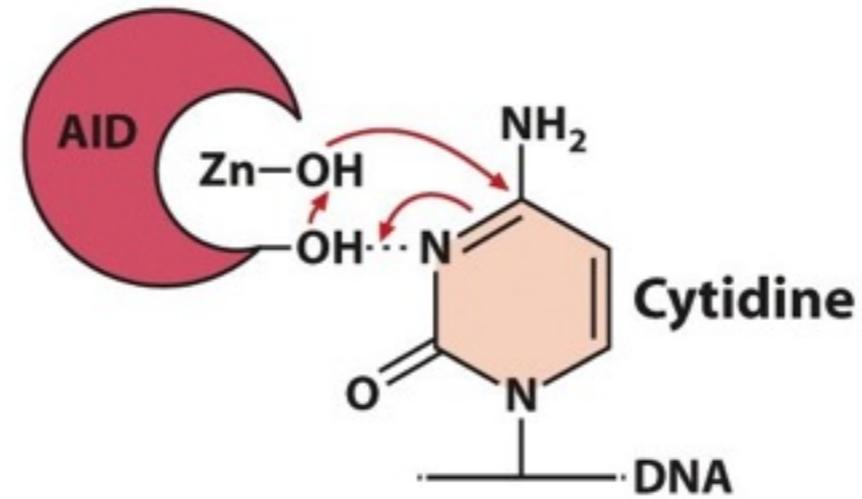
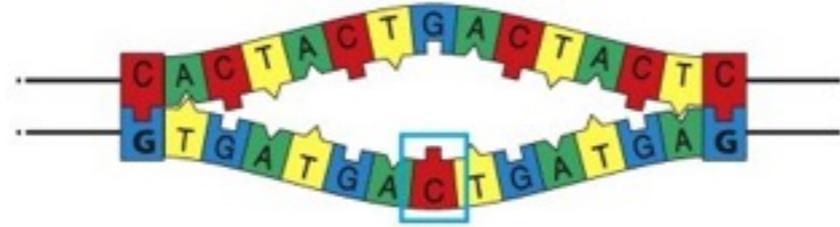


Figure 5.21 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

## Single-stranded DNA attacked by AID



## AID transition state

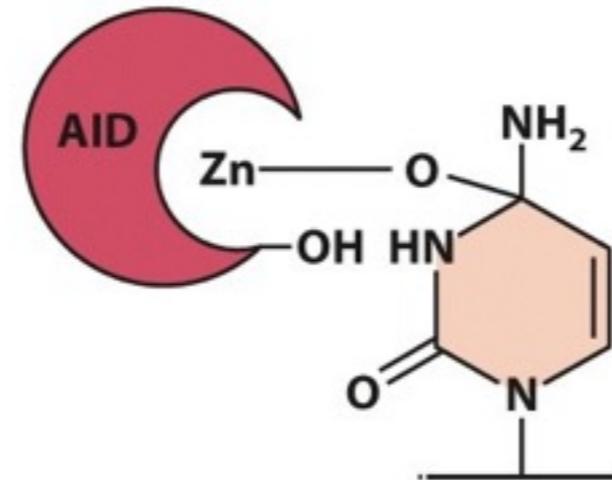


Figure 5.21 part 1 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

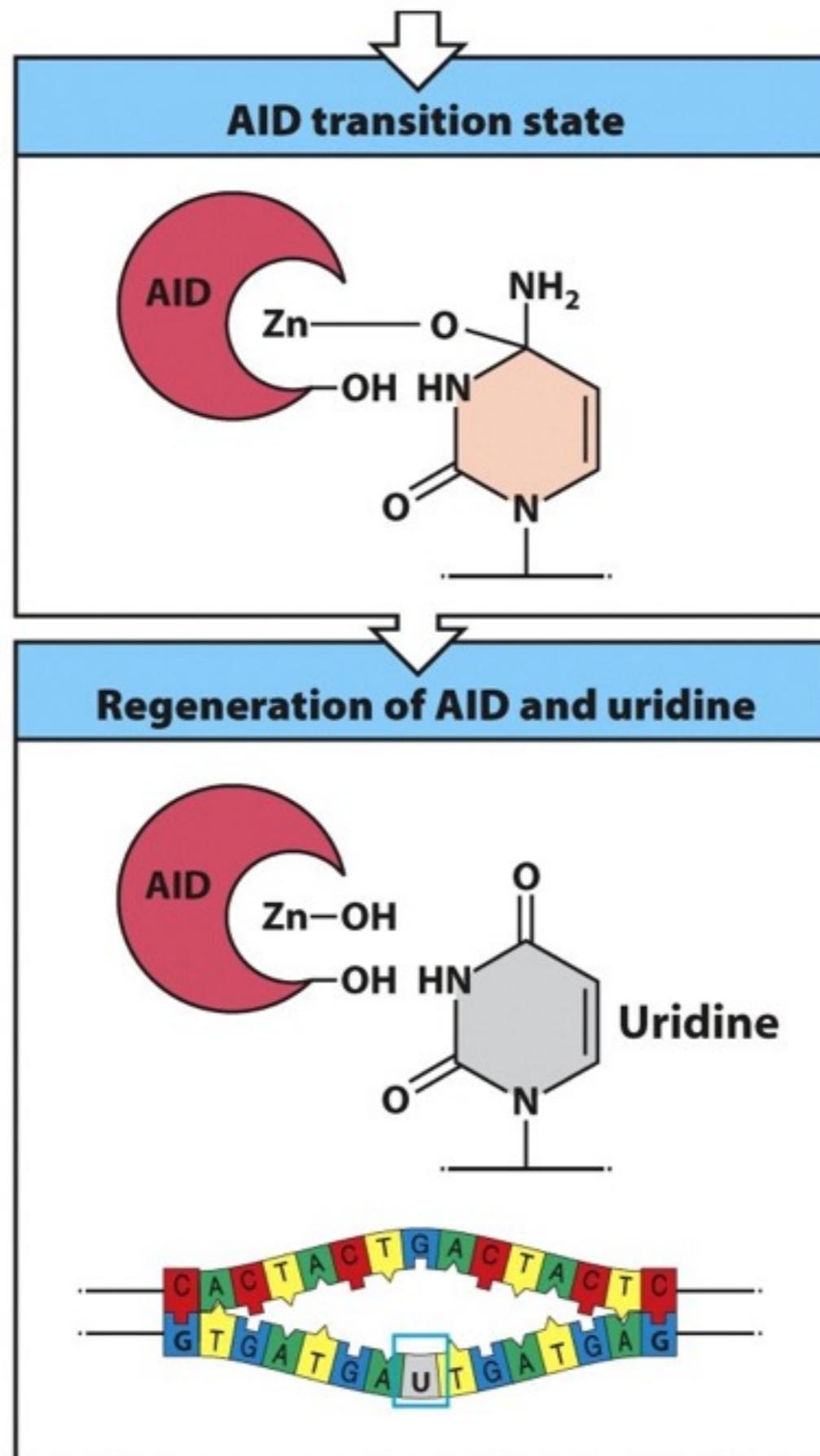


Figure 5.21 part 2 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

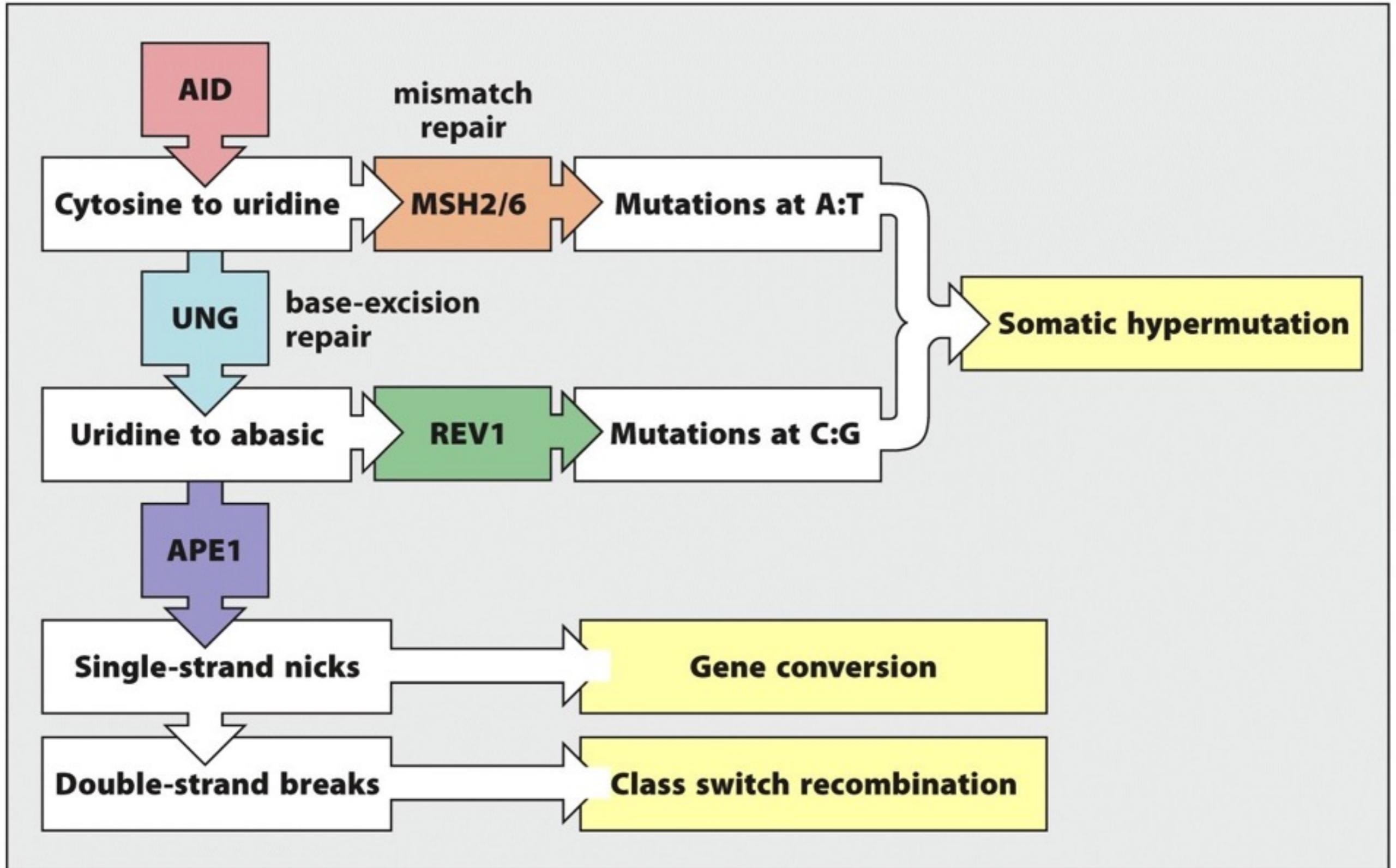
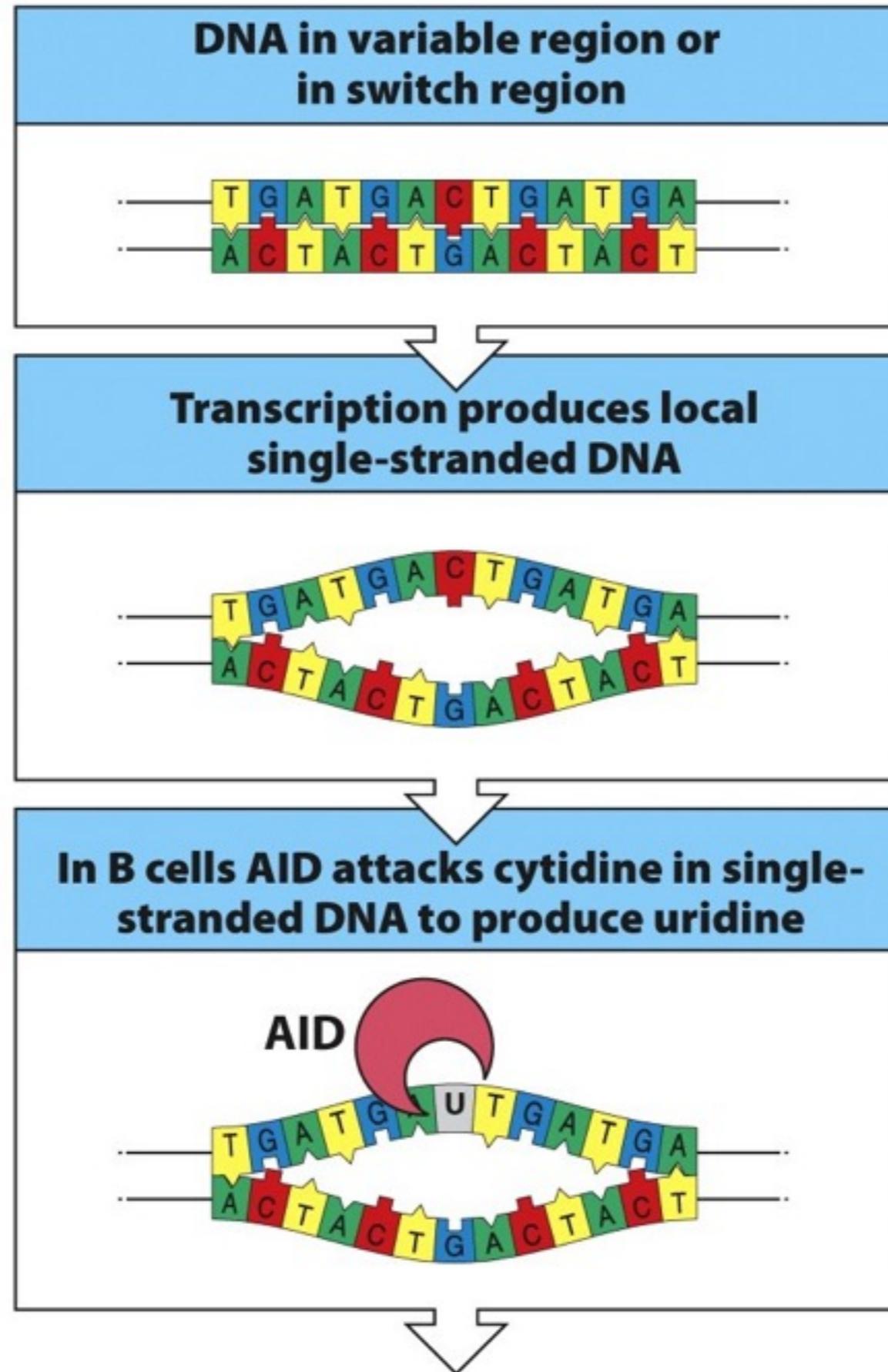
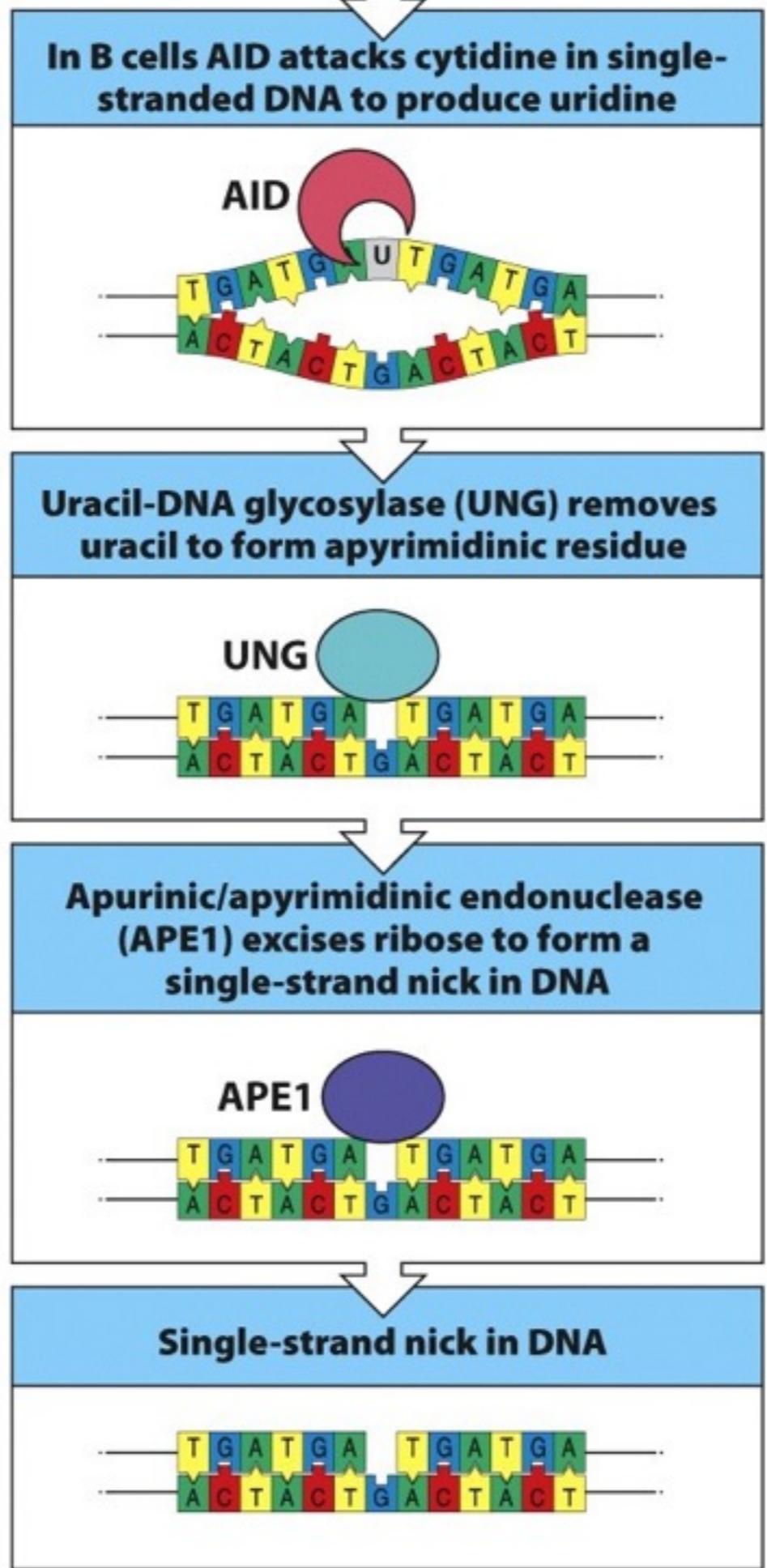


Figure 5.22 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



Hipermutação  
Somática  
ou  
Maturação de  
Afinidade

Figure 5.23 part 1 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



Hipermutação  
Somática  
ou  
Maturação de  
Afinidade

Figure 5.23 part 2 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

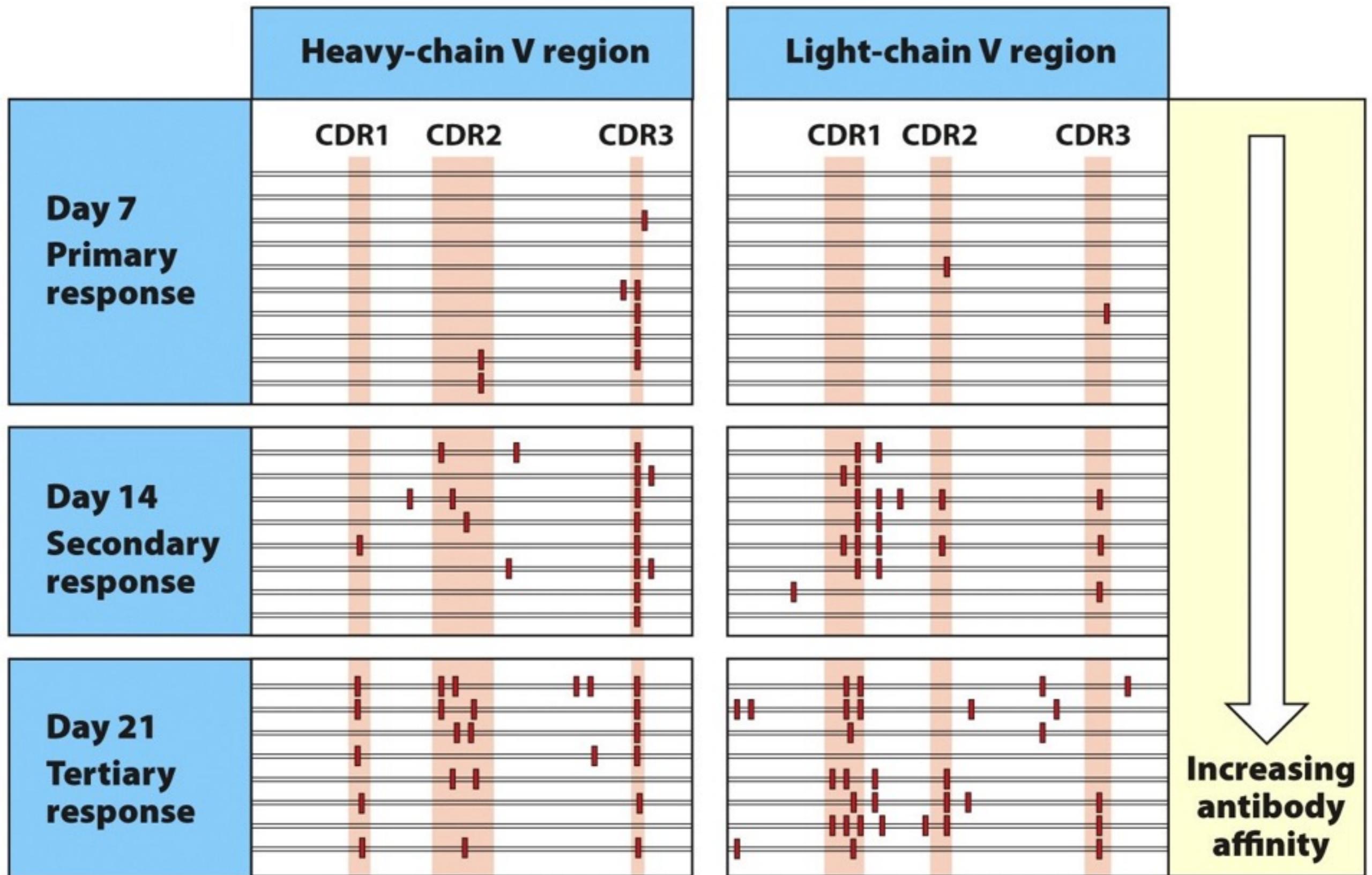
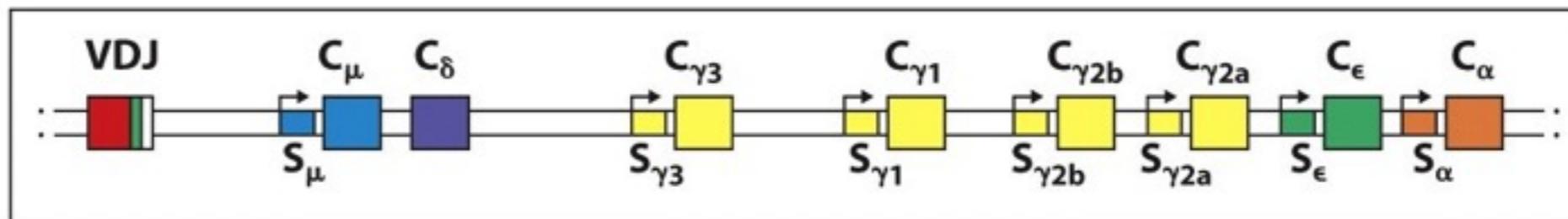


Figure 5.24 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

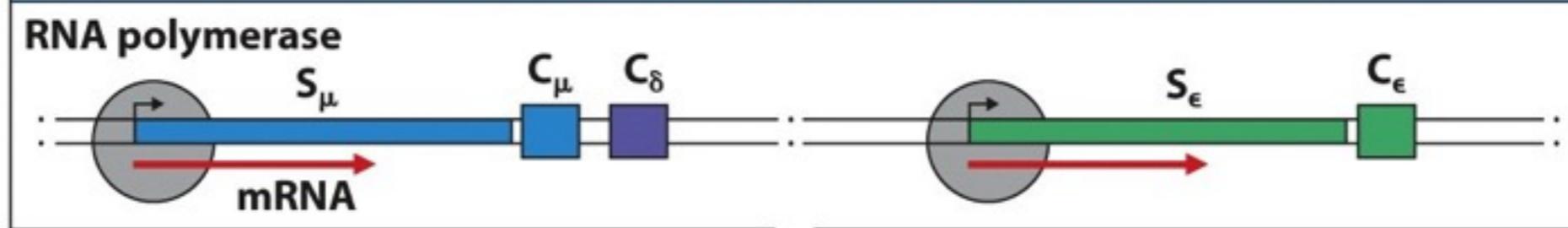
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- \* **troca de classe ou isotipo → somente B**
- \* conversão fênica → somente B





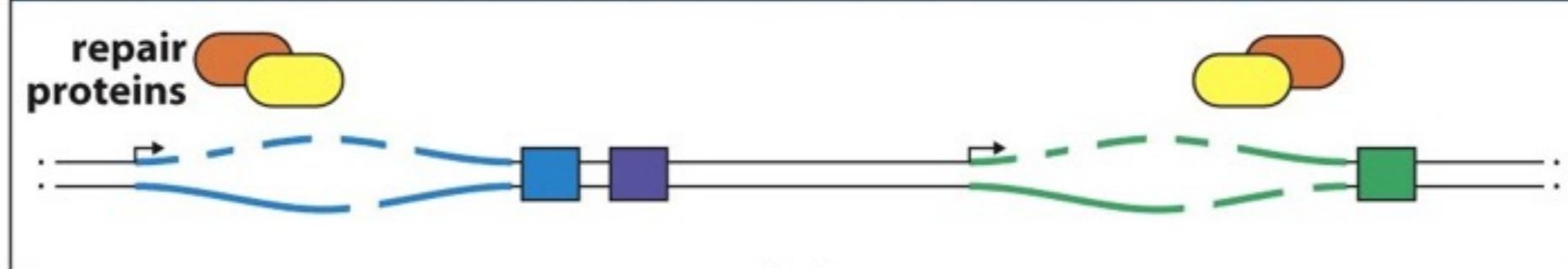
**Transcription through the switch region is initiated by activation of the upstream promoter**



**AID, UNG, and APE1 introduce clustered nicks on both strands of DNA**

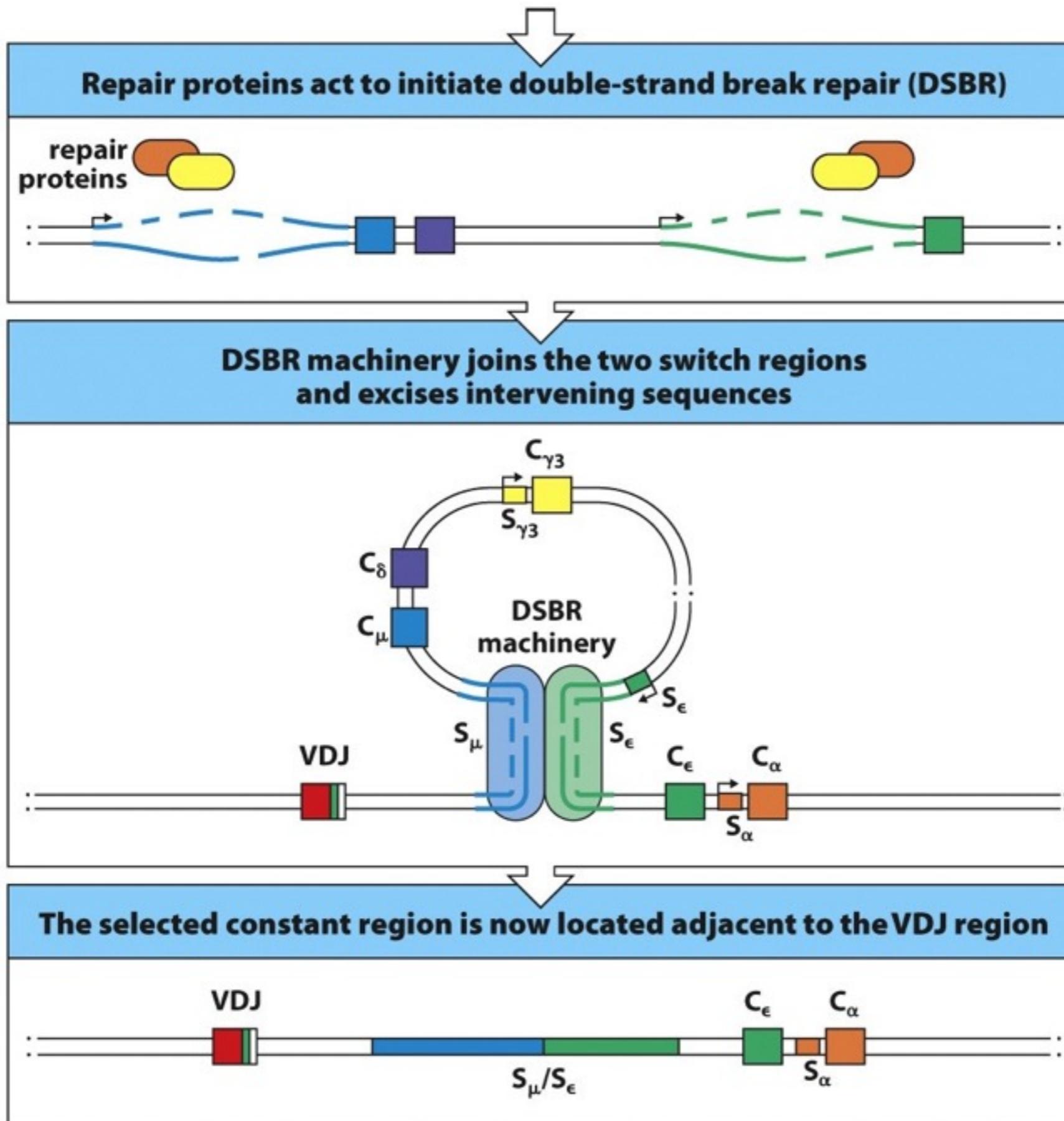


**Repair proteins act to initiate double-strand break repair (DSBR)**



Troca de  
Classe  
ou  
Troca de  
Isotipo

Figure 5.25 part 1 of 2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)



Troca de  
Classe  
ou  
Troca de  
Isotipo

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Event	Process	Nature of change	Process occurs in:	
			B cells	T cells
V-region assembly	Somatic recombination of DNA	Irreversible	Yes	Yes
Junctional diversity	Imprecise joining, N-sequence insertion in DNA	Irreversible	Yes	Yes
Transcriptional activation	Activation of promoter by proximity to the enhancer	Irreversible but regulated	Yes	Yes
Switch recombination	Somatic recombination of DNA	Irreversible	Yes	No
Somatic hypermutation	DNA point mutation	Irreversible	Yes	No
IgM, IgD expression on surface	Differential splicing of RNA	Reversible, regulated	Yes	No
Membrane vs secreted form	Differential splicing of RNA	Reversible, regulated	Yes	No

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conceito importante!