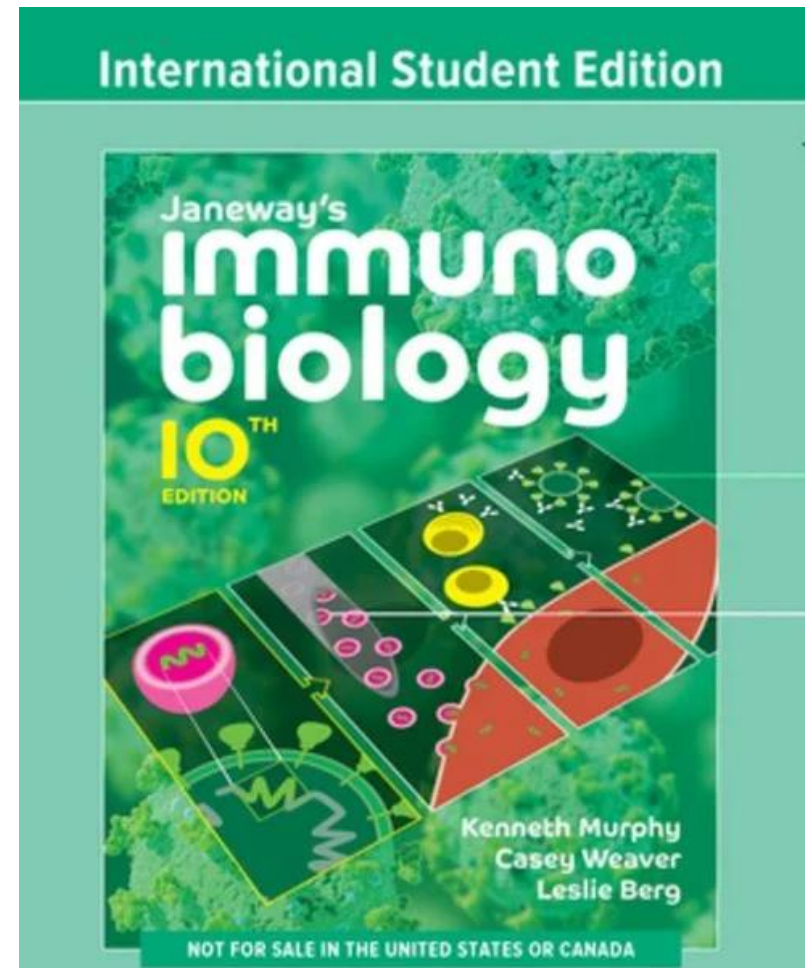
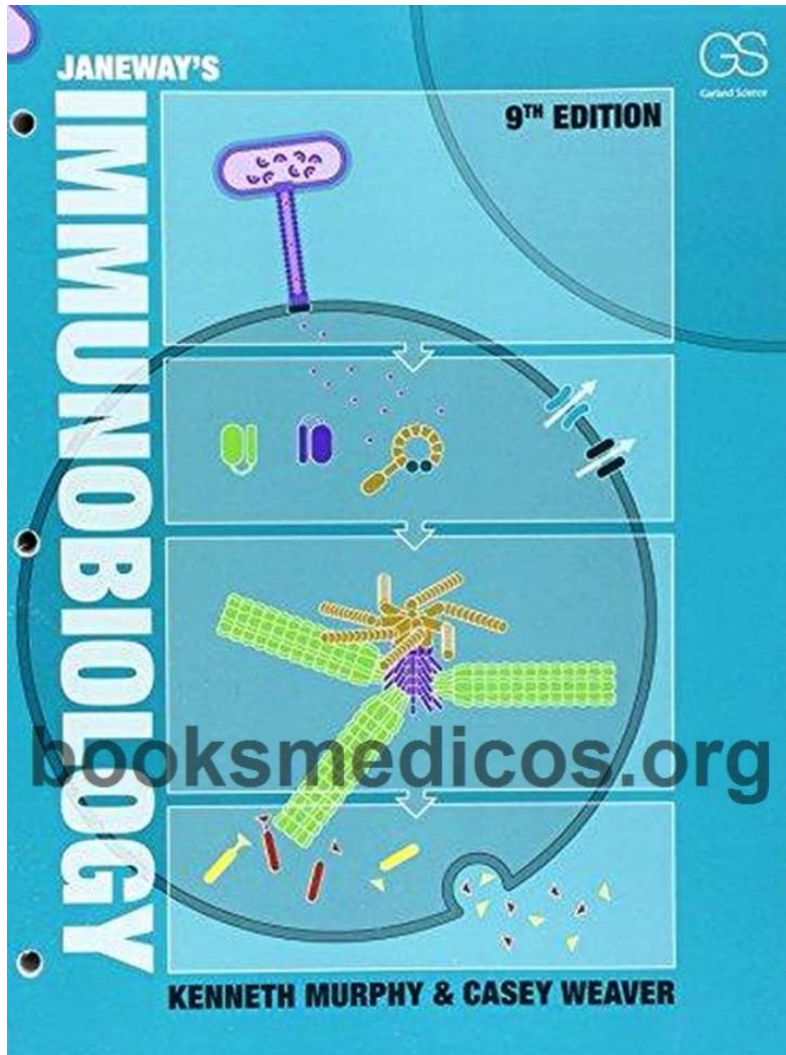


Immunology

Introduction into the immune system

22.04.2026, Ruhr-Universität Bochum

Marcus Peters, marcus.peters@rub.de



<https://moodle.ruhr-uni-bochum.de/mod/folder/view.php?id=3251934>

What is necessary for successful participation?

MSc: attendance at lectures +
giving a seminar talk and oral exam (30min)

BSc: attendance at lectures +
oral exam (30 min)

PhD: attendance at lectures

Oral exam will take place in August/September

Date	Topic	Lecturer
22.04.26	Introduction	Peters
29.04.26	Innate Immunity	Plaza Sirvent
06.05.26	Antigen presentation & Tcells	Plaza Sirvent
13.05.26	Signal transduction in Immune cells I	Plaza Sirvent
20.05.26	Signal transduction in Immune cells II	Plaza Sirvent
27.05.26	Pentecost holidays	
03.06.26	Immunoregulation	Plaza Sirvent
10.06.26	Immunological methods	Plaza Sirvent
17.06.26	B-cell biology & Antibodies	Peters
24.06.26	Complement system	Peters
01.07.26	Allergies & Autoimmunity	Peters
08.07.26	Manipulation of the immune response	Knobloch
15.07.26	Infection and failure of host defense	Knobloch

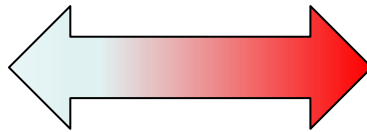
What is the function of the immune system?

Protection from invading pathogens

Removal/repair of damaged tissue

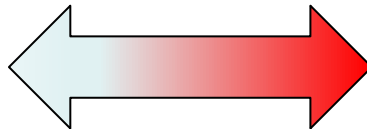
The immune system discriminates between

self



foreign

harmless



dangerous

Potential threats to the body

Virus

Bacteria

Fungi

Parasites

Surface layer:

Outer membrane

Inner membrane

Core wall

Core

DNA genome

Virion enzymes

A

Fig. A: Structure of Poxvirus



B

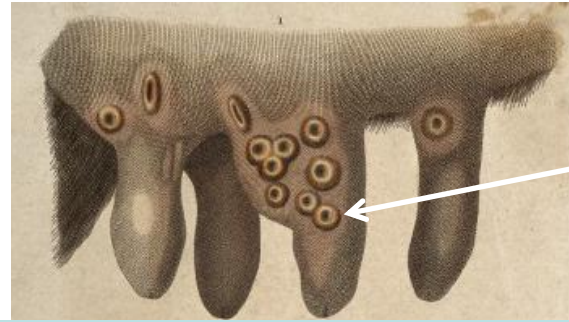
Fig. B: Smallpox

**Parasitic worms
(extracellular)**

Ascaris
Schistosoma

**Ascariasis
Schistosomiasis**

The birth-hour of vaccination



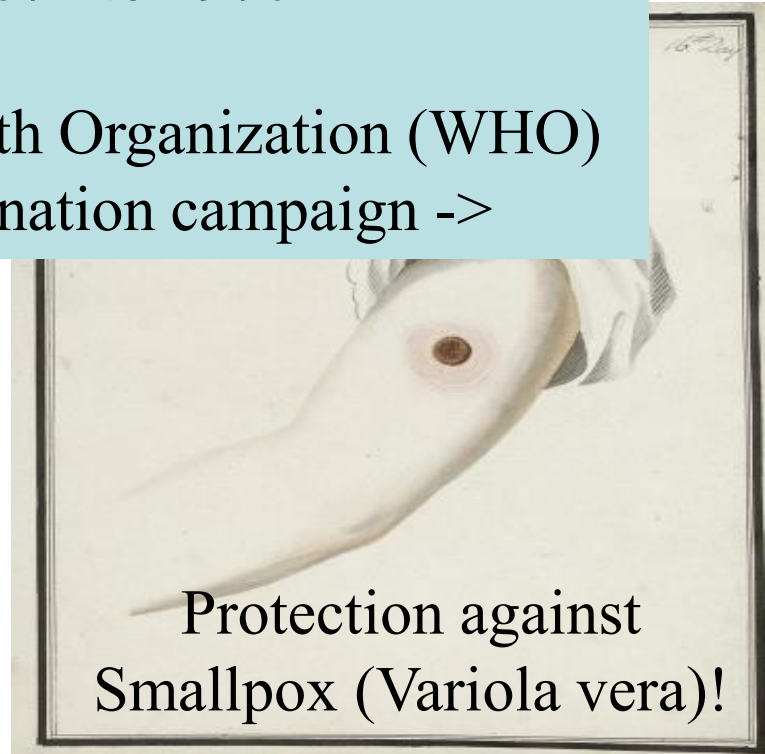
Cowpox
(*Variola
vaccinae*)
on the
udder

Mandatory vaccination against small pox in
Germany from 1874 to 1976

1958 to 1977, the World Health Organization (WHO)
conducted a global vaccination campaign ->



Edward Jenner (1749-1823)



Protection against
Smallpox (*Variola vera*)!

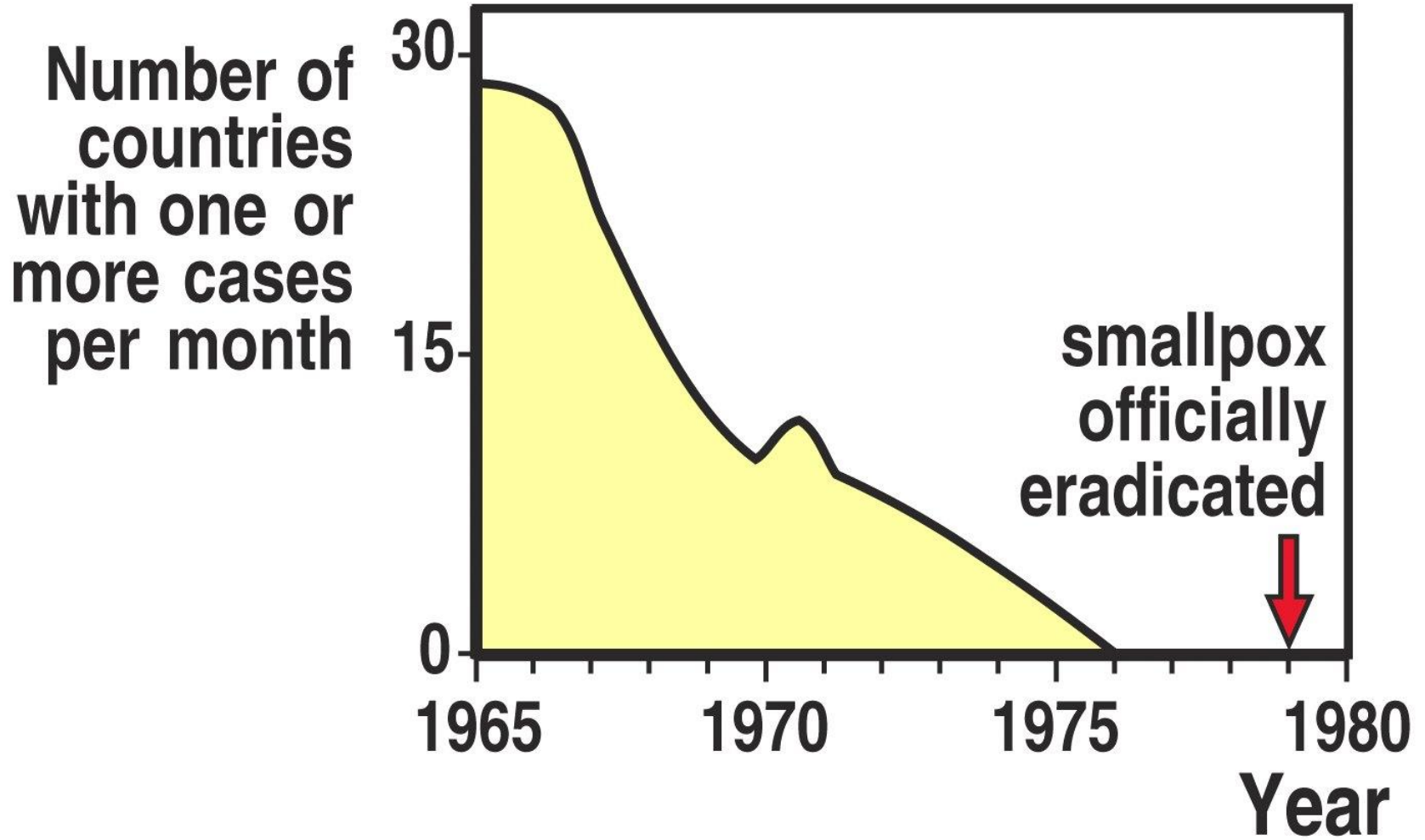
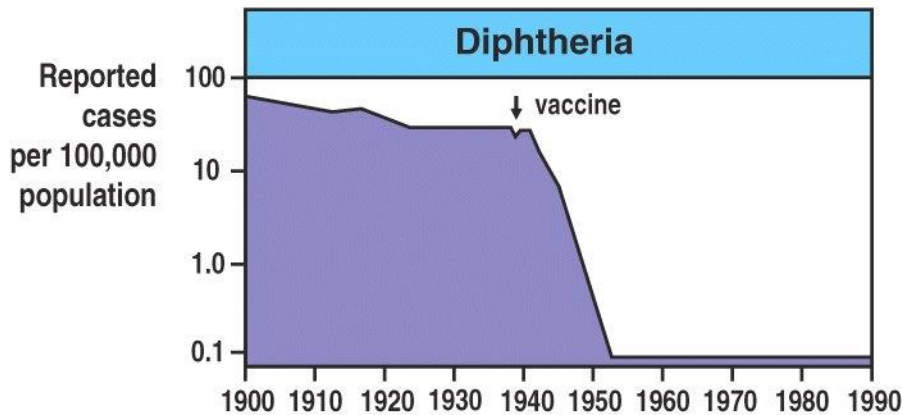
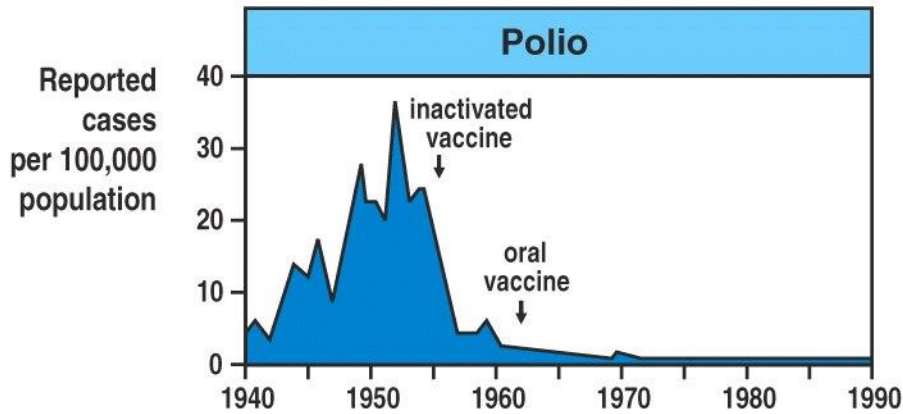


Figure 1-2 Immunobiology, 6/e. (© Garland Science 2005)



serious bacterial infection caused by *Corynebacterium diphtheriae*. affects the mucous membranes of the nose and throat, producing a toxin that creates a thick, gray coating, causing severe breathing and swallowing difficulties.



poliomyelitis, is a highly infectious viral disease that primarily affects children under five. It attacks the nervous system, potentially causing permanent paralysis or death within hours.

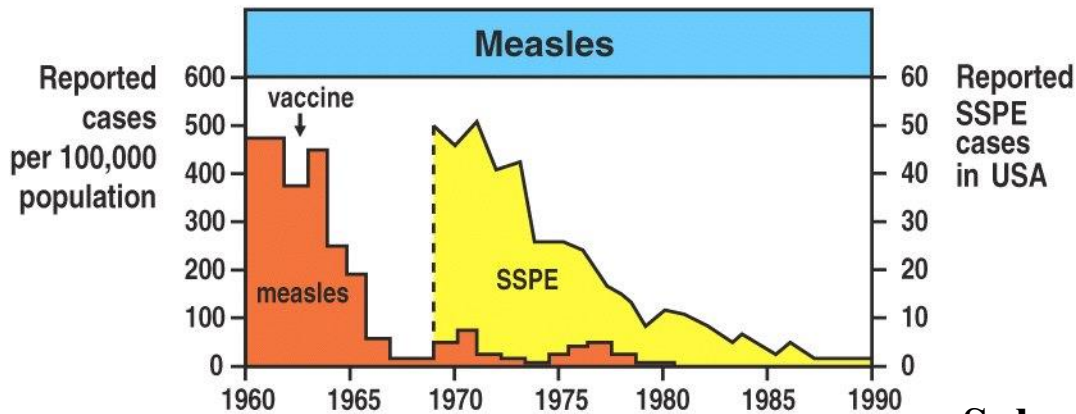


Figure 1-33 Immunobiology, 6/e. (© Garland Science 2005)

Subacute sclerosing panencephalitis (SSPE)

Milestones in cancer immunotherapy

William B Coley, injected bacteria into the tumors to treat cancer

1891

The first Chimeric Antigen Receptor (CAR) was generated in 1989 by the Zelig Eshhar group in Israel

1989

Allison's team founded immune checkpoint blockade CTLA-4 first time demonstrated that an inhibiting negative immune regulator

1994-1997

Ipilimumab, the first antibody targeting CTLA-4, was approved for the treatment of unresectable or metastatic melanoma

2011

FDA approved the first CAR-T product, Kymriah from Novartis

2017

IL-2 was discovered to play an essential role in T cell differentiation and growth

1974

Tasuku Honjo at Kyoto University discovered programmed cell death protein 1 (PD-1)

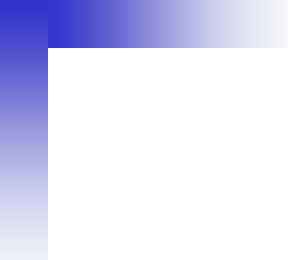
1992

Lieping Chen discovered a molecule named B7-H1, which as a ligand to PD-1

1999

Nivolumab (Opdivo), the first antibody targeting PD-1, was approved for the treatment of melanoma

2014



Introduction to the key players of the Immune System

Innate versus adaptive Immunity

The innate immune system is **the first line of defense against invading pathogens**. Innate immune responses rely on the body's ability to recognize conserved features of pathogens that are not present in the uninfected host.

The adaptive immune system involves **specialized immune cells and antibodies which are able to adapt** to the structure of a foreign antigen. It attacks and destroys foreign antigens and is able to prevent disease in the future by remembering what those substances look like.

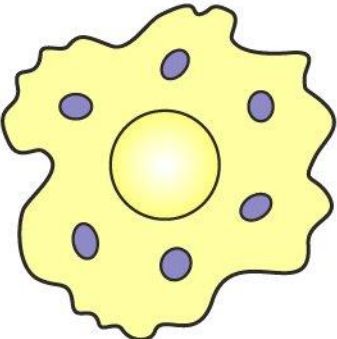
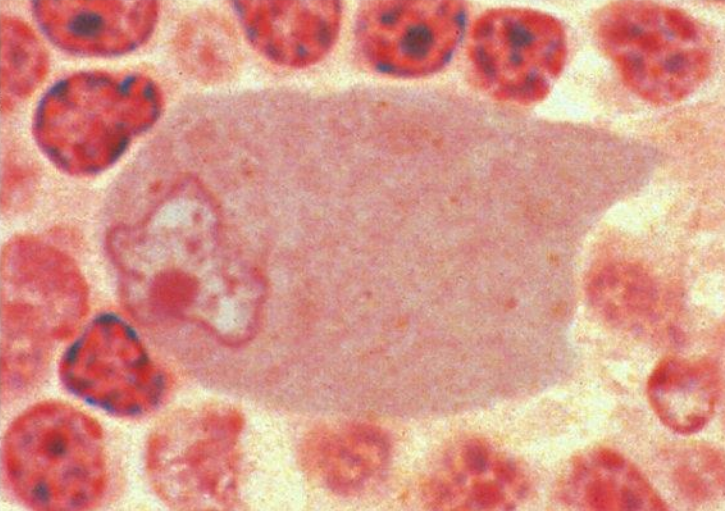
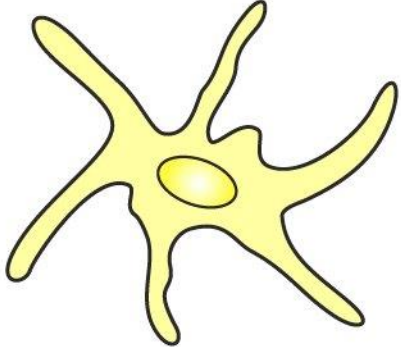

Cell	Activated function	
<p data-bbox="102 239 658 344">Macrophage</p> 		<p data-bbox="1406 239 1829 596">Phagocytosis and activation of bactericidal mechanisms</p> <p data-bbox="1406 611 1829 732">Antigen presentation</p>
<p data-bbox="102 789 658 893">Dendritic cell</p> 		<p data-bbox="1406 789 1829 1018">Antigen uptake in peripheral sites</p> <p data-bbox="1406 1032 1829 1260">Antigen presentation in lymph nodes</p>

Figure 1-4 part 1 of 3 Immunobiology, 6/e. (© Garland Science 2005)

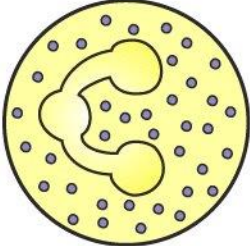



Cell		Activated function
Neutrophil Granulocyte 		Phagocytosis and activation of bactericidal mechanisms
Eosinophil Granulocyte 		Killing of antibody-coated parasites

Figure 1-4 part 2 of 3 Immunobiology, 6/e. (© Garland Science 2005)

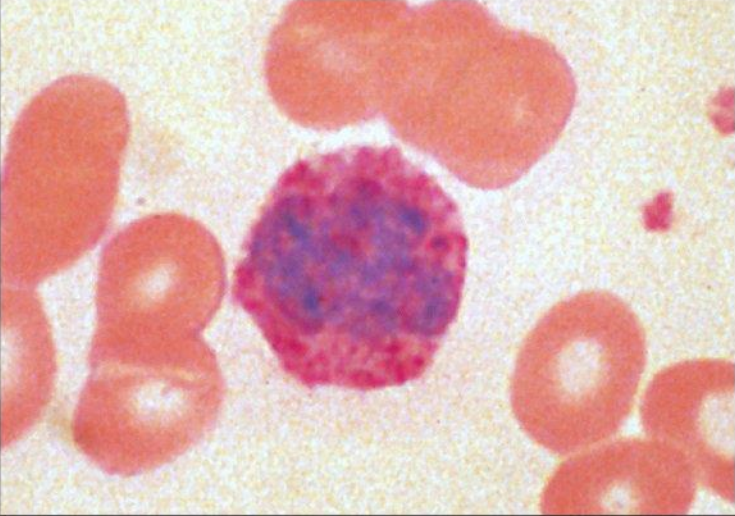
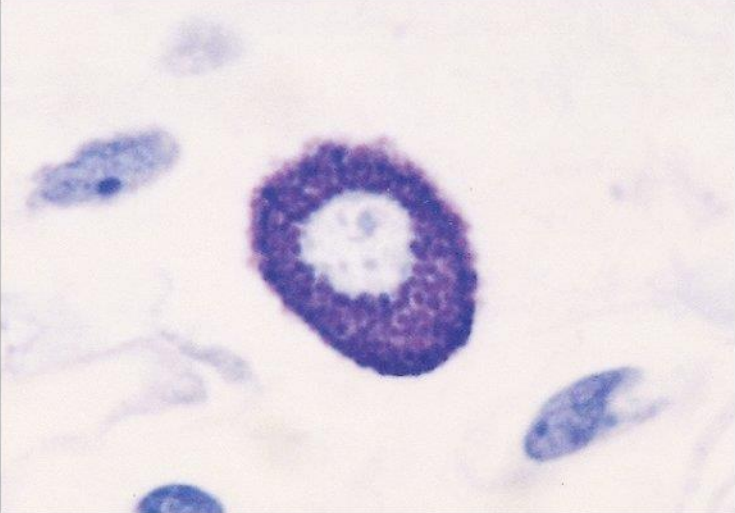
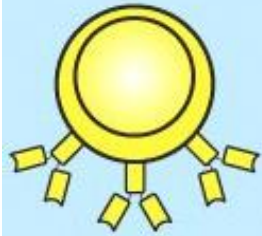
Cell	Activated function	
Basophil	 <p>A light micrograph showing a central basophil with a dark purple, granular nucleus and a pale, granular cytoplasm. It is surrounded by several red blood cells, which appear as bright orange-red discs.</p>	<p>Unknown</p>
Mast cell	 <p>A light micrograph showing a central mast cell with a large, pale, oval nucleus and a dense, dark purple granular cytoplasm. Other smaller cells with blue nuclei are visible in the background.</p>	<p>Release of granules containing histamine and other active agents</p>

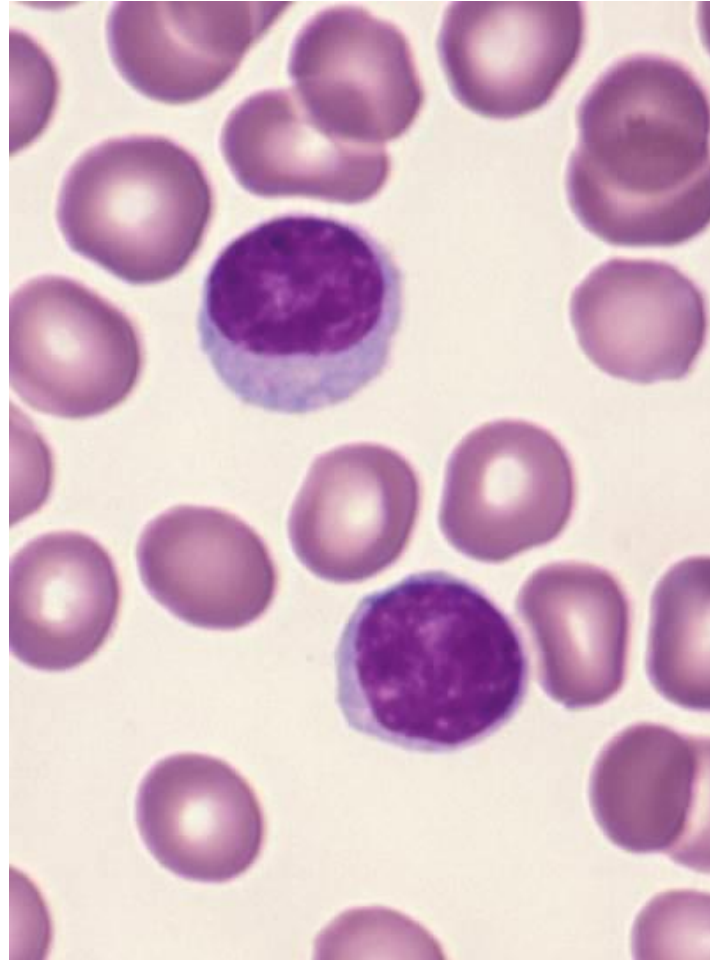
Figure 1-4 part 3 of 3 Immunobiology, 6/e. (© Garland Science 2005)

Cell

**Activated
function**



B cell



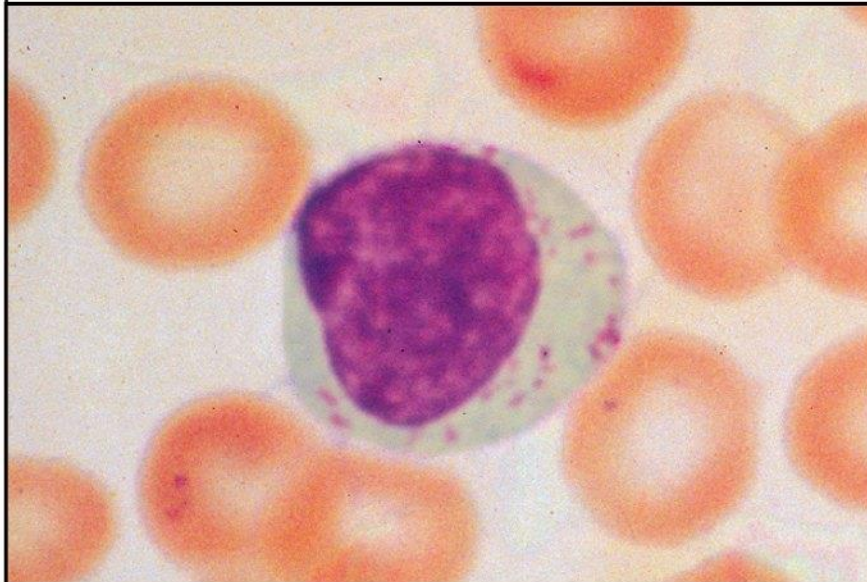
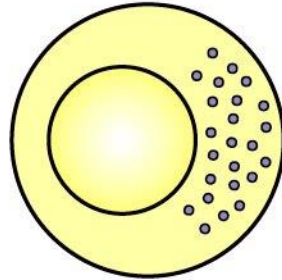
antigen
presentation,
production of
Antibodies
(plasma cell)



T cell

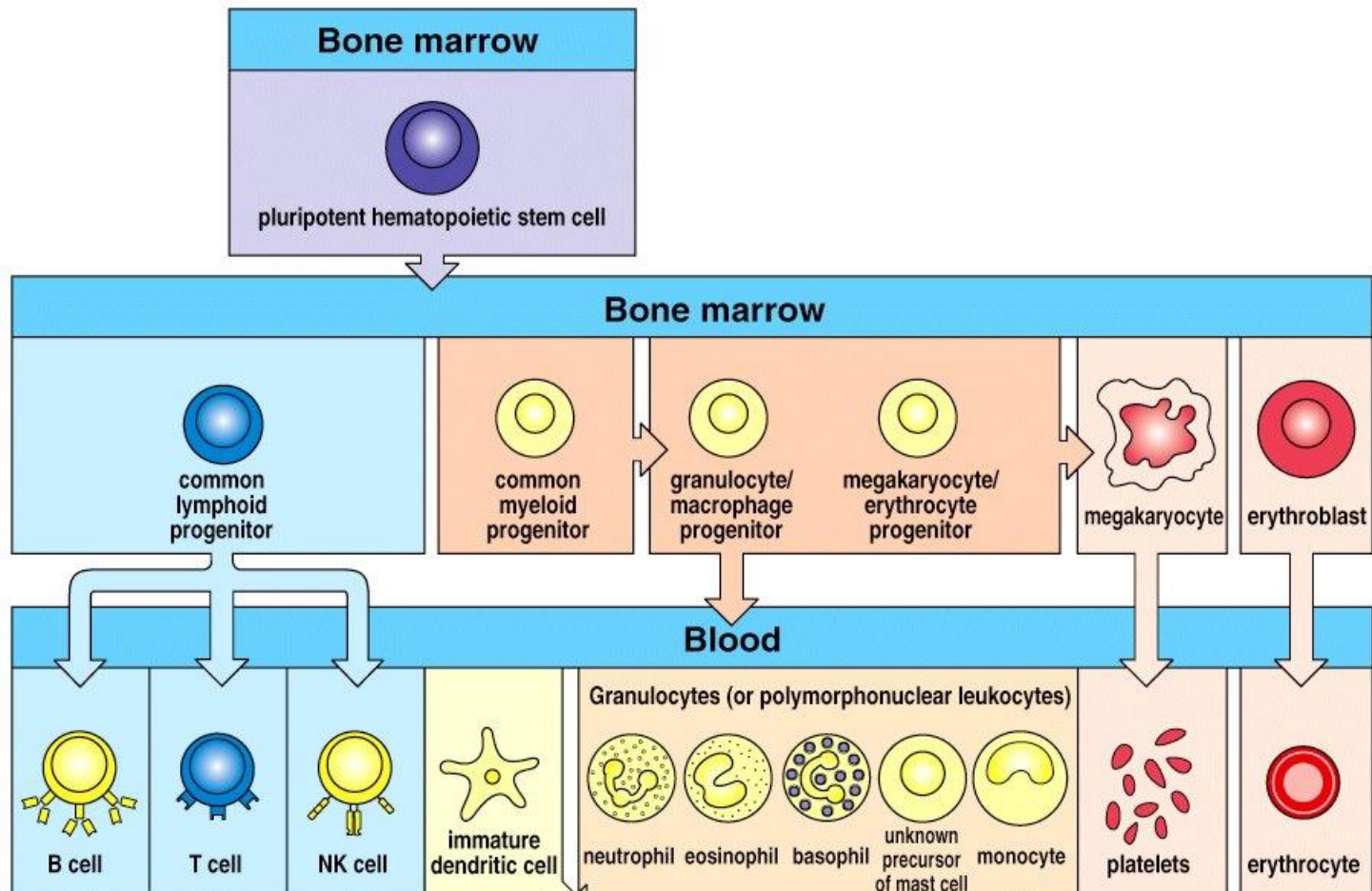
Killing of
infected
cells,
activation of
other
immune cells

Natural killer (NK) cell



Releases lytic granules that kill some virus-infected cells

The immune cells (leukocytes) and their precursors



The immune cells are organized in the lymphatic system

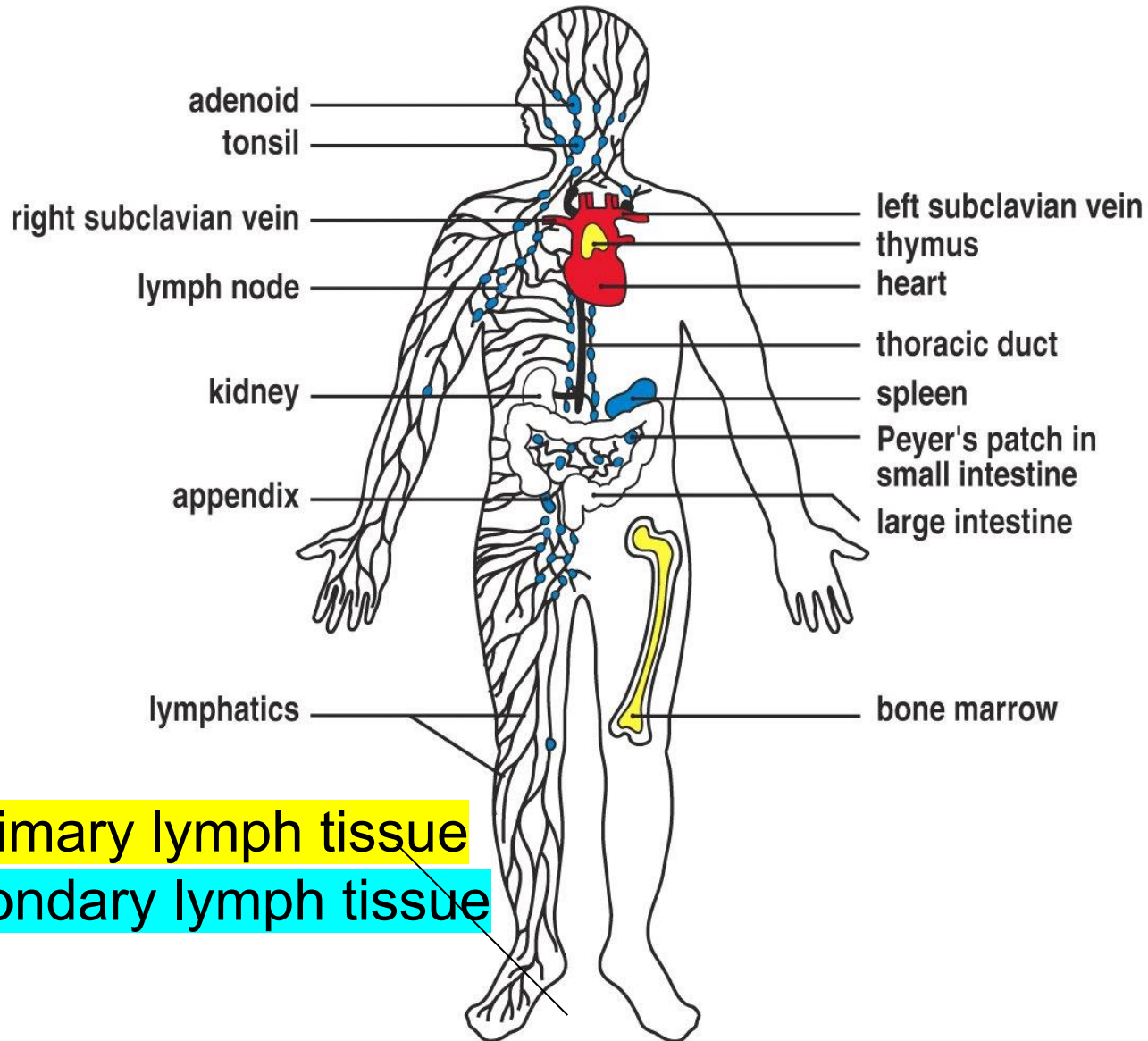


Figure 1-7 Immunobiology, 6/e. (© Garland Science 2005)

Histologic appearance of a lymph node

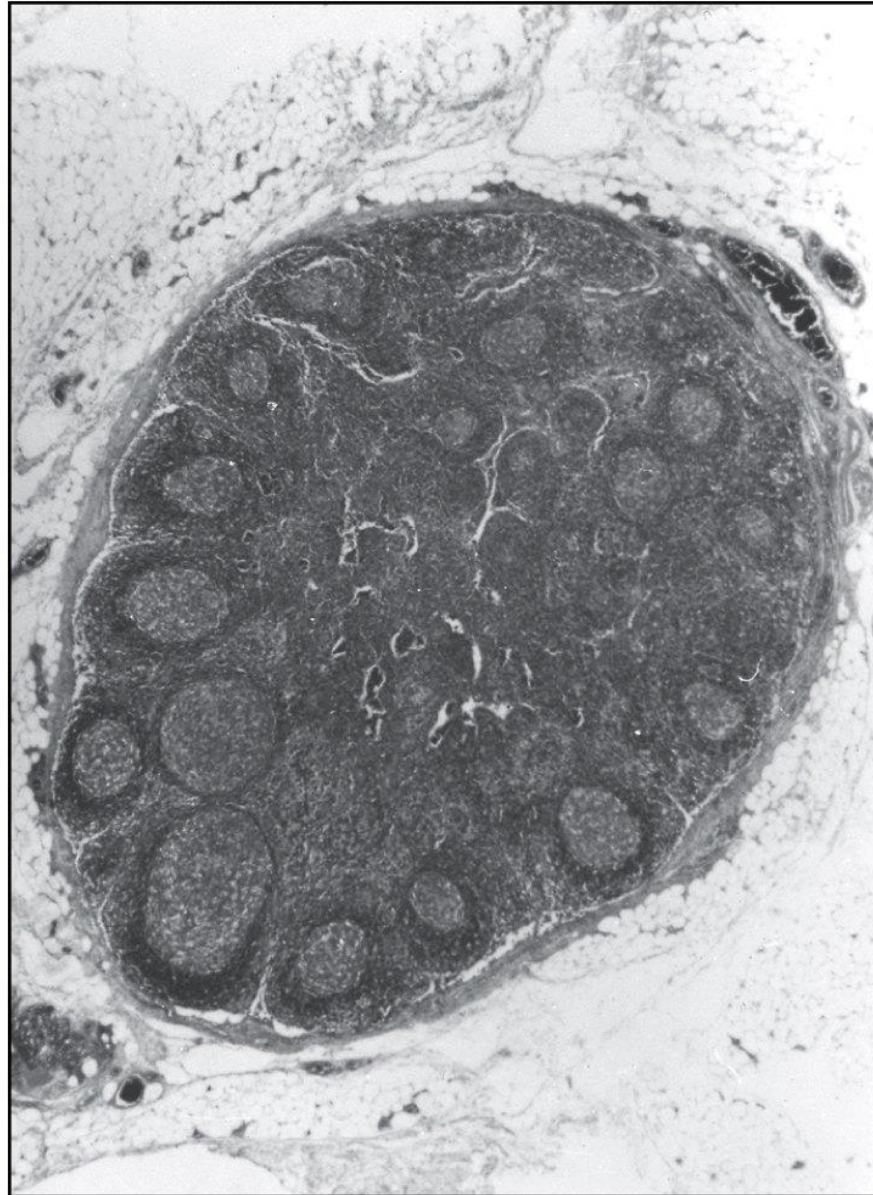


Figure 1-8 part 2 of 2 Immunobiology, 6/e. (© Garland Science 2005)

A lymph node

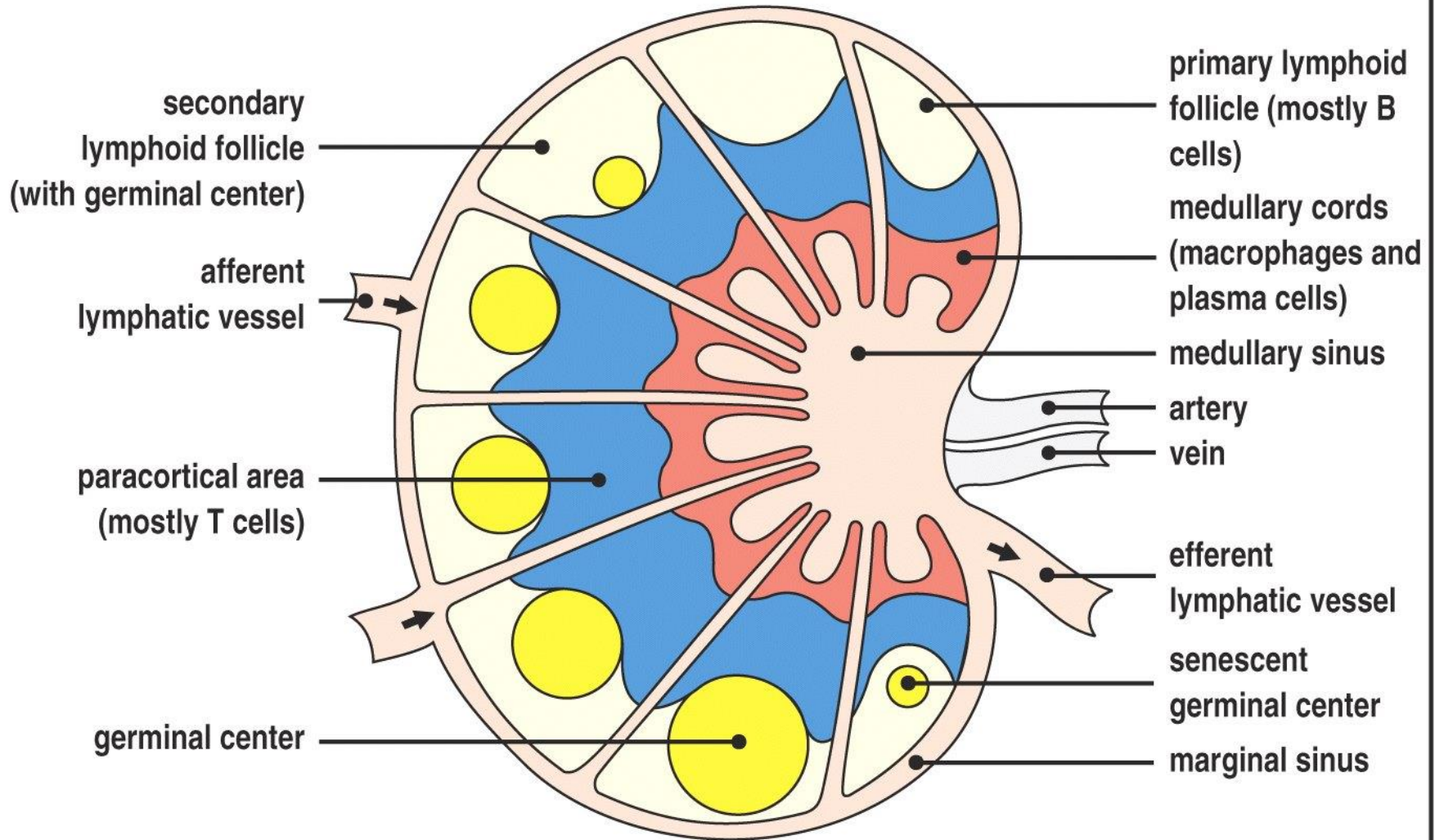
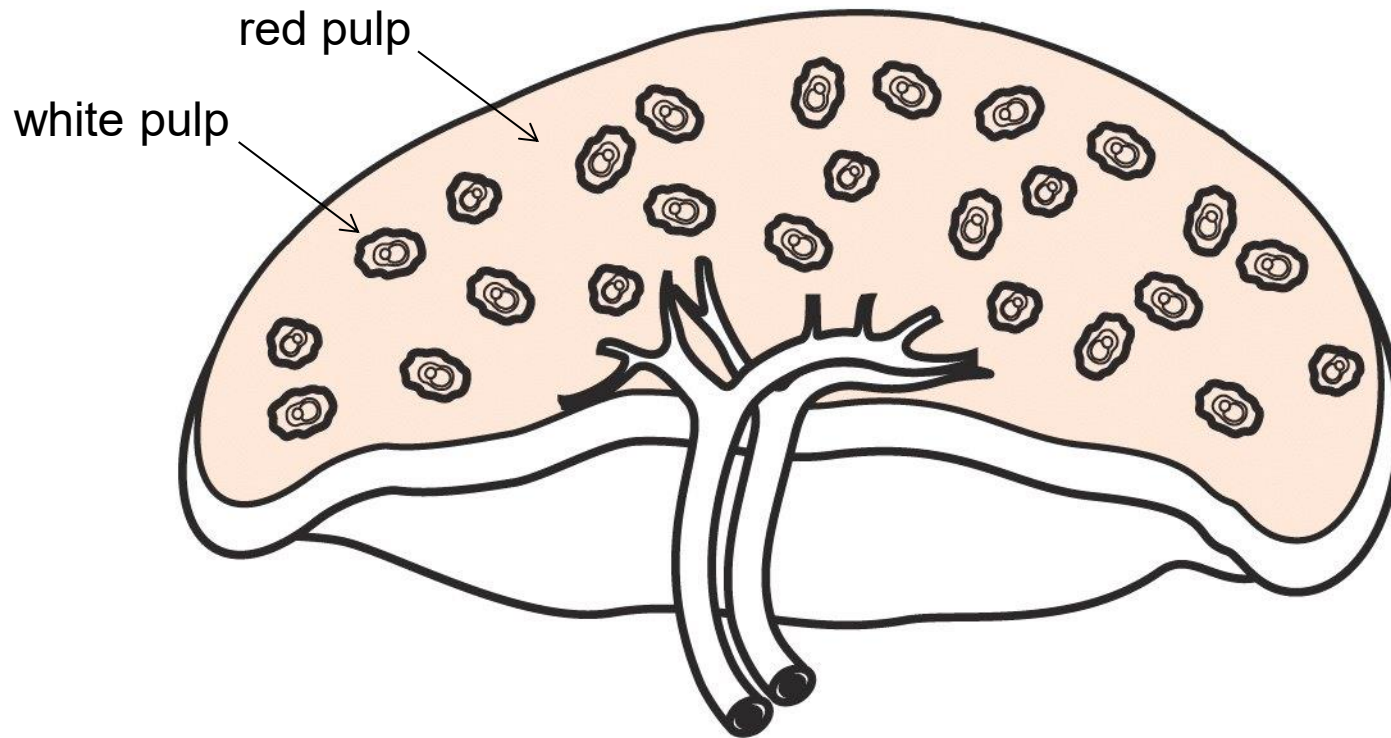


Figure 1-8 part 1 of 2 Immunobiology, 6/e. (© Garland Science 2005)

The spleen



Peyer's Patches

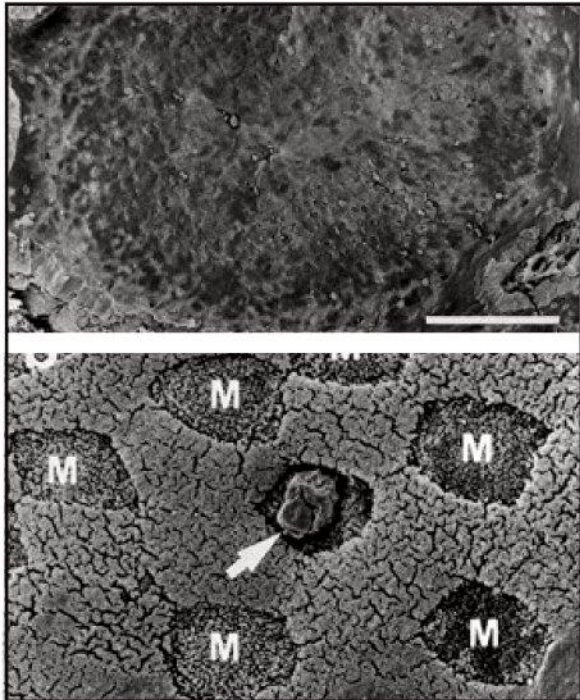
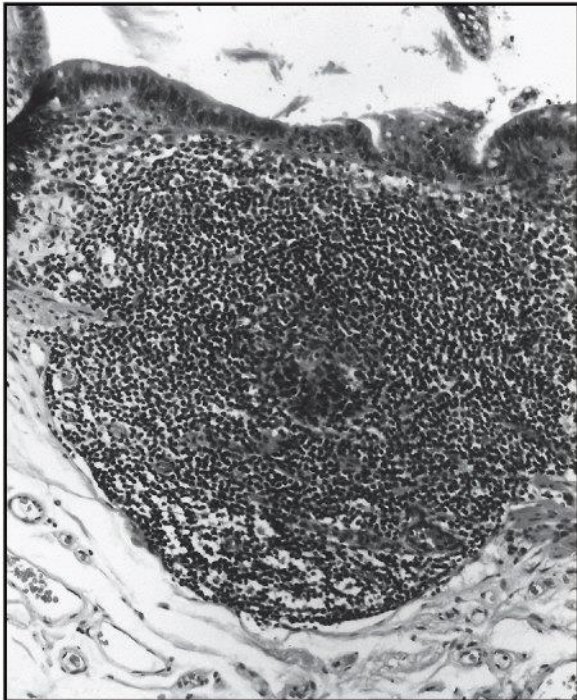
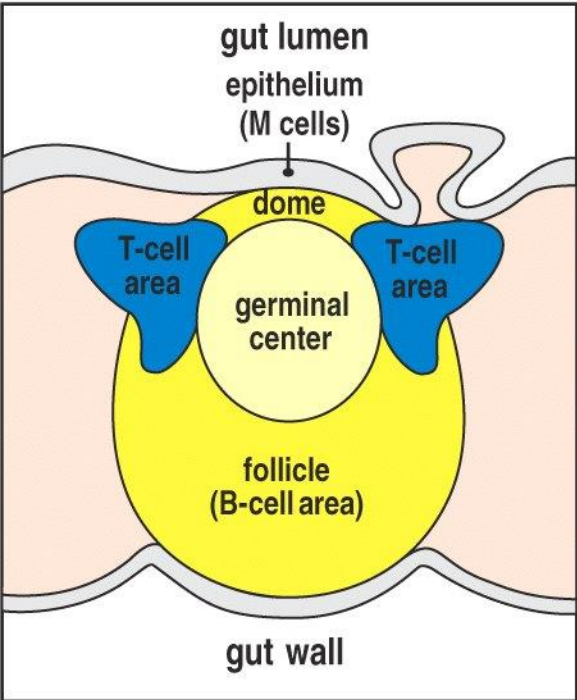


Figure 1-10 Immunobiology, 6/e. (© Garland Science 2005)

CHARACTERISTICS OF INNATE IMMUNITY

NATURAL/INNATE

- Rapid, prompt response (hours)
- No variable receptors
- No improvement during the response
- No memory
- Not transferable
- Can be exhausted, saturated

ADAPTIVE/ACQUIRED

- Time consuming (several days)
- Variable antigen receptors
- Efficacy is improving during the response
- Memory
- Can be transferred
- Regulated, limited



**COMMON EFFECTOR MECHANISMS FOR THE
ELIMINATION OF PATHOGENS**

Activation of an innate immune response at sites of infection results in inflammation

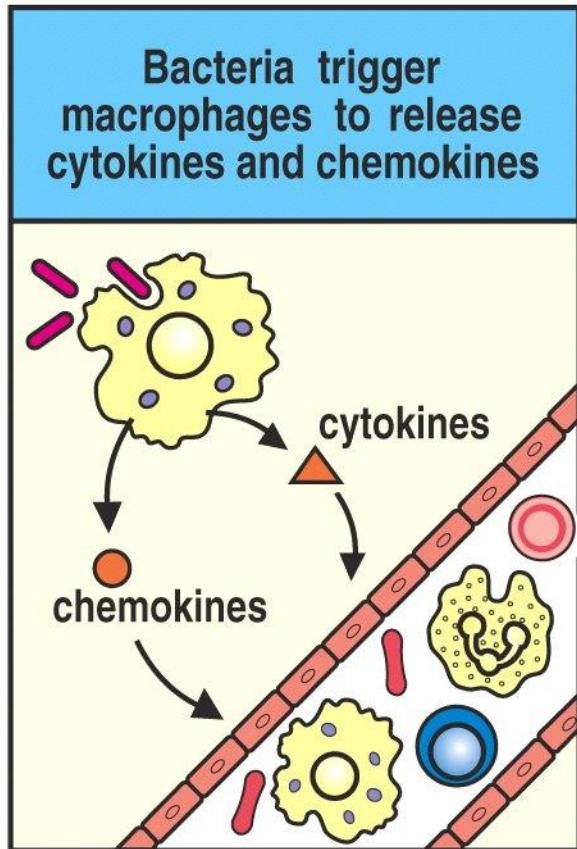
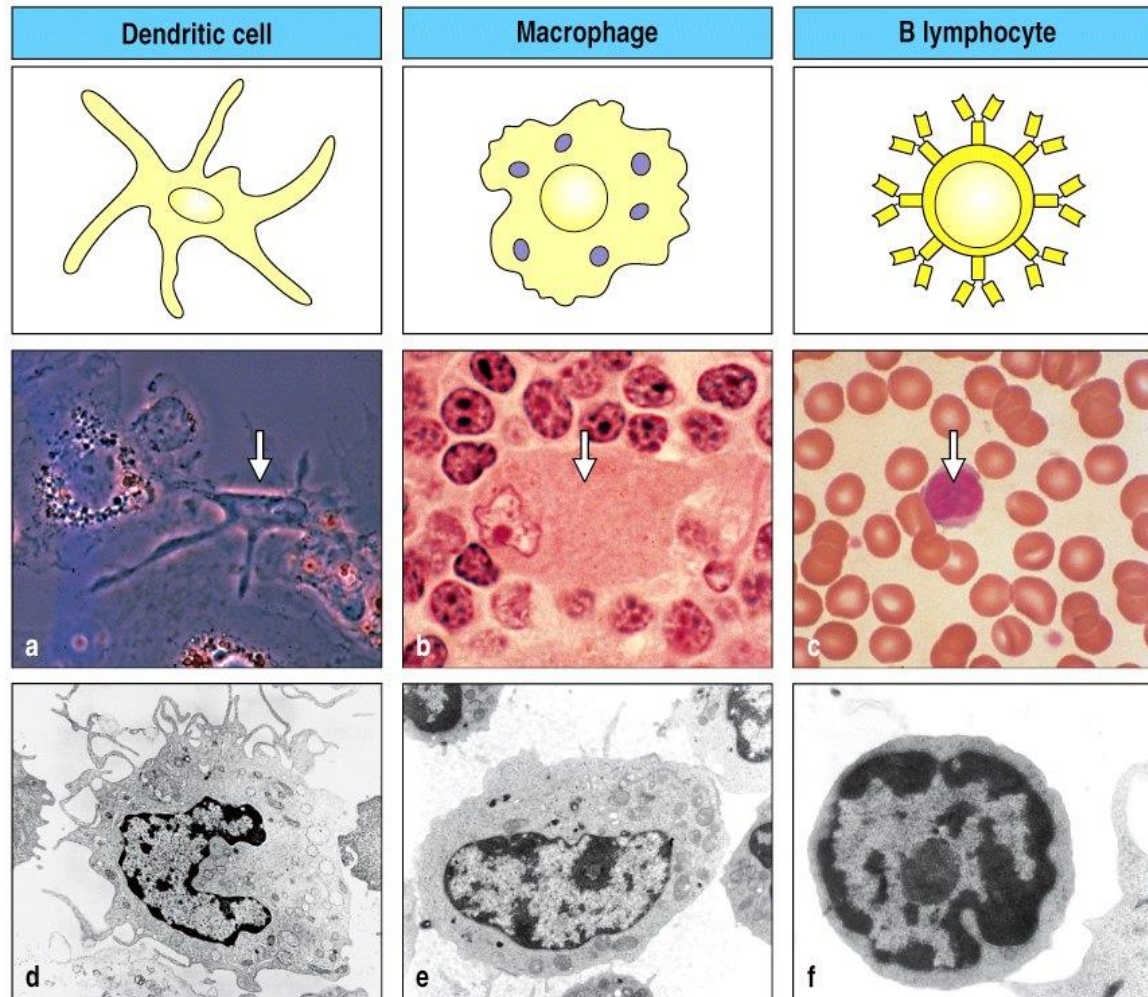


Figure 1-12 Immunobiology, 6/e. (© Garland Science 2005)

Cytokines = small proteins that can act in an autocrine, endocrine or paracrine manner „hormones of the immune system“
Chemokines = Cytokines with chemotactic activity

Antigen presenting cells – linking innate with Adaptive immunity



Antigen presenting molecules
MHC=major histocompatibility complex

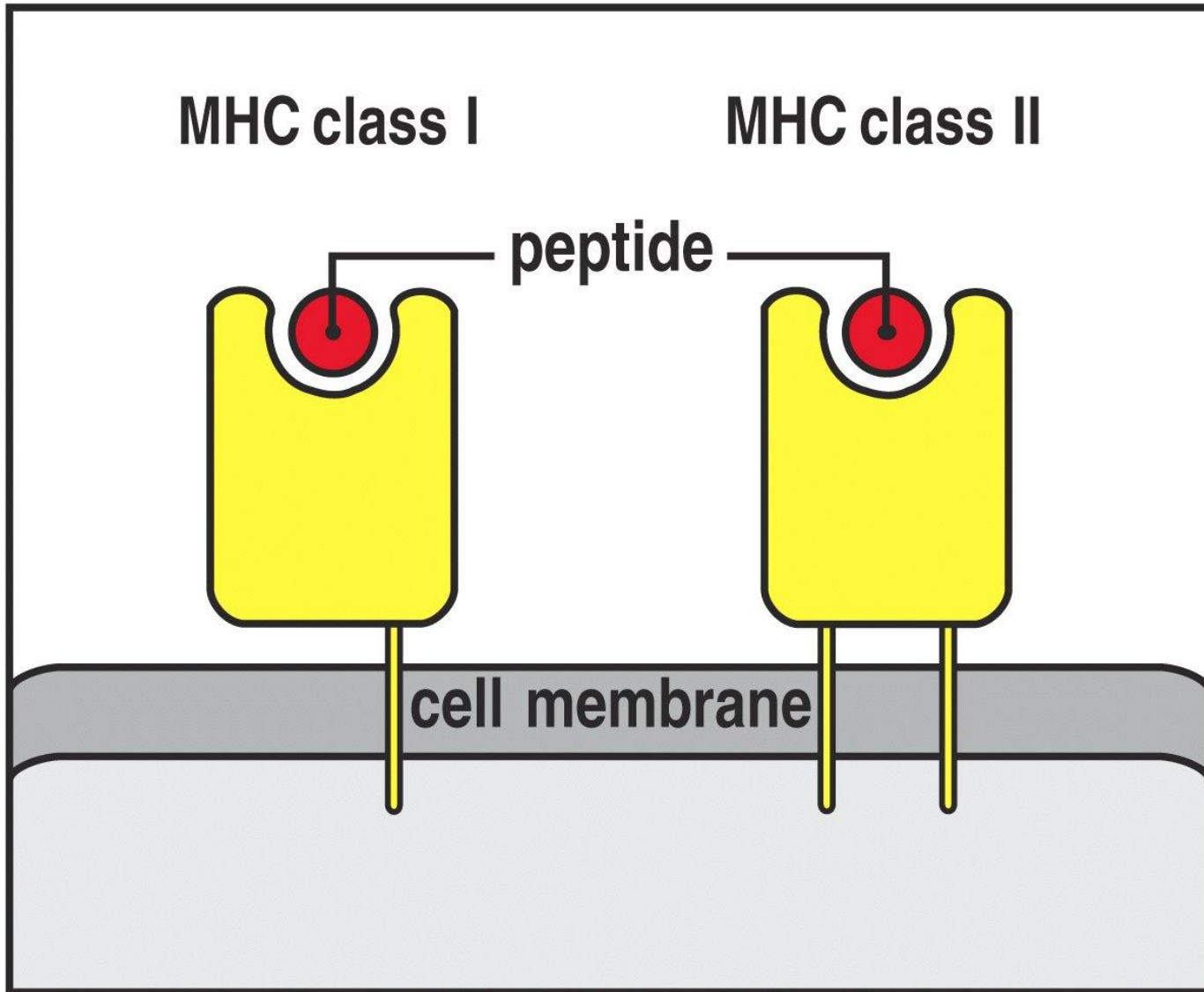


Figure 1-27 Immunobiology, 6/e. (© Garland Science 2005)

Presentation of peptides on MHC I molecules

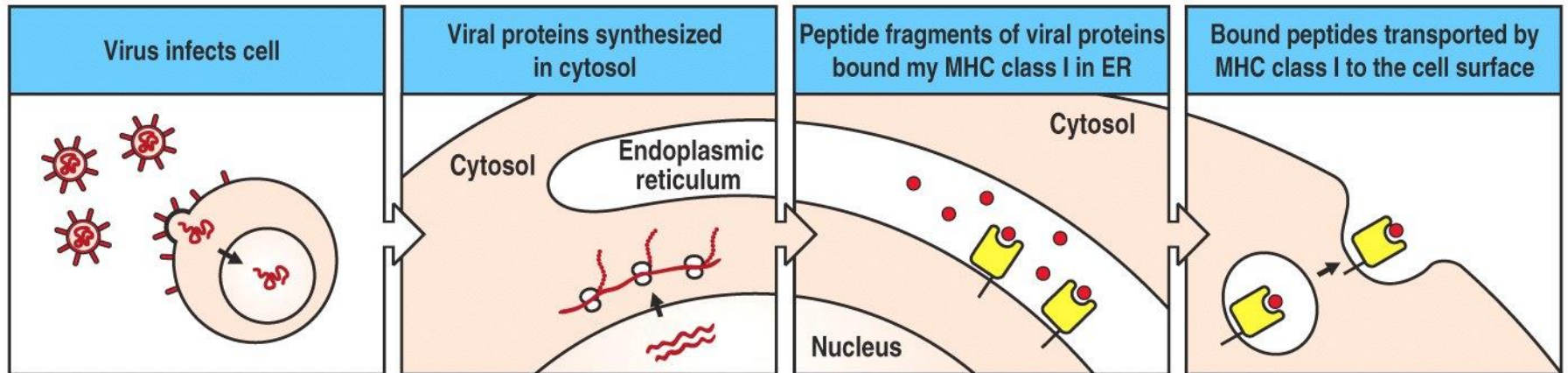


Figure 1-28 Immunobiology, 6/e. (© Garland Science 2005)

Presentation of peptides on MHC II molecules

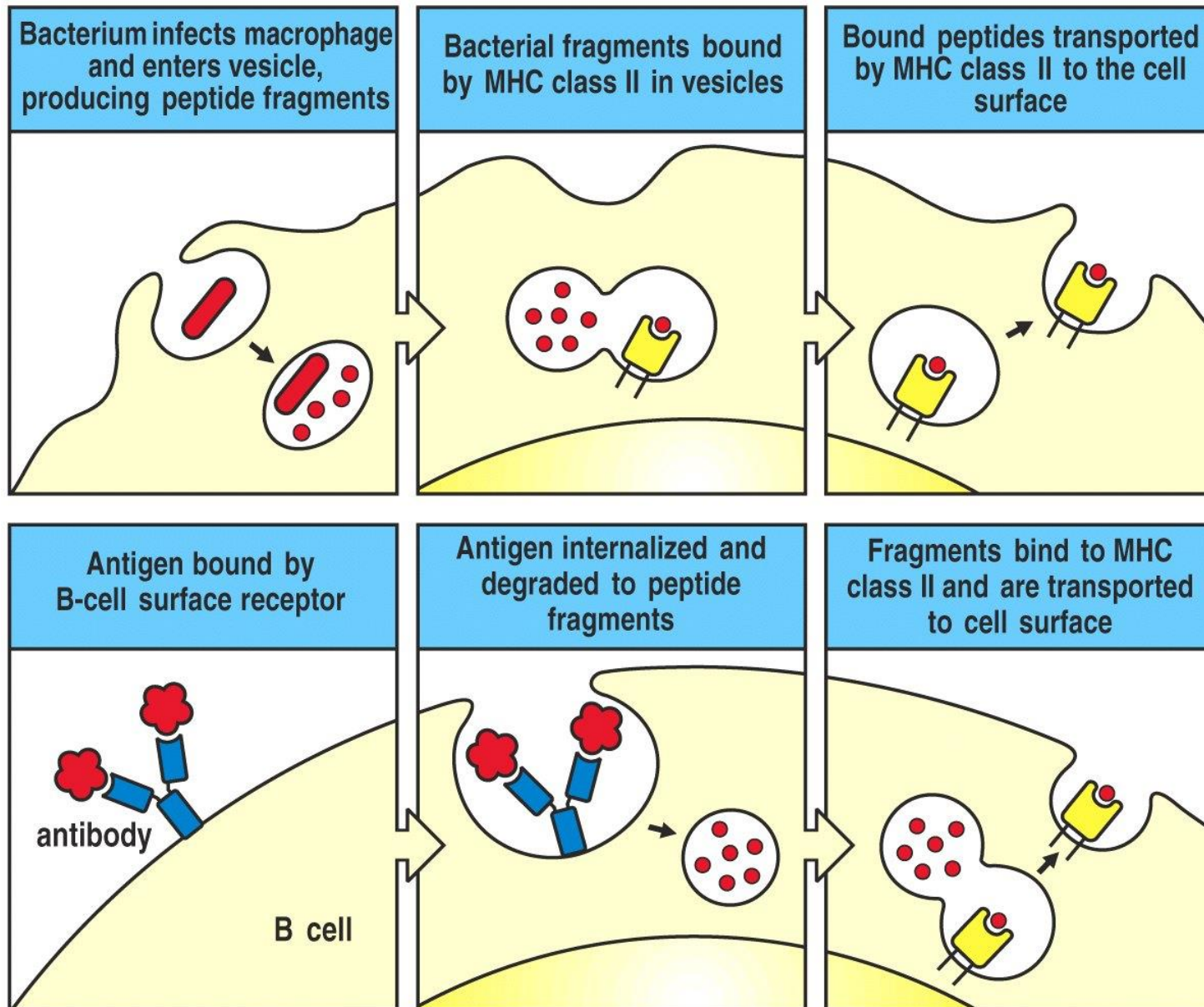


Figure 1-29 Immunobiology, 6/e. (© Garland Science 2005)

The activation of effector T-lymphocytes

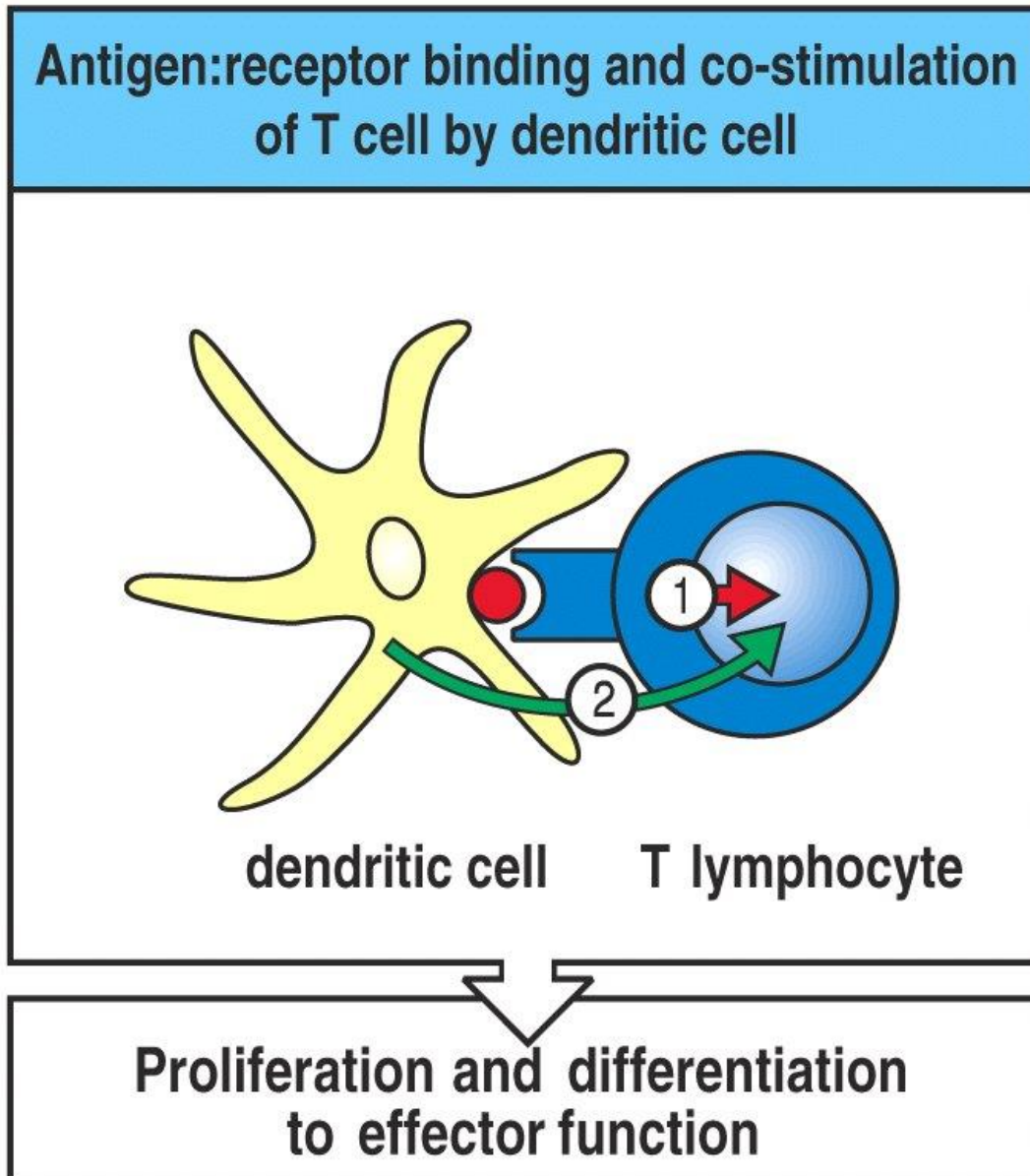


Figure 1-21 Immunobiology, 6/e. (© Garland Science 2005)

The effector function of cytotoxic T-cells

Cytotoxic T cell recognizes complex of viral peptide with MHC class I and kills infected cell

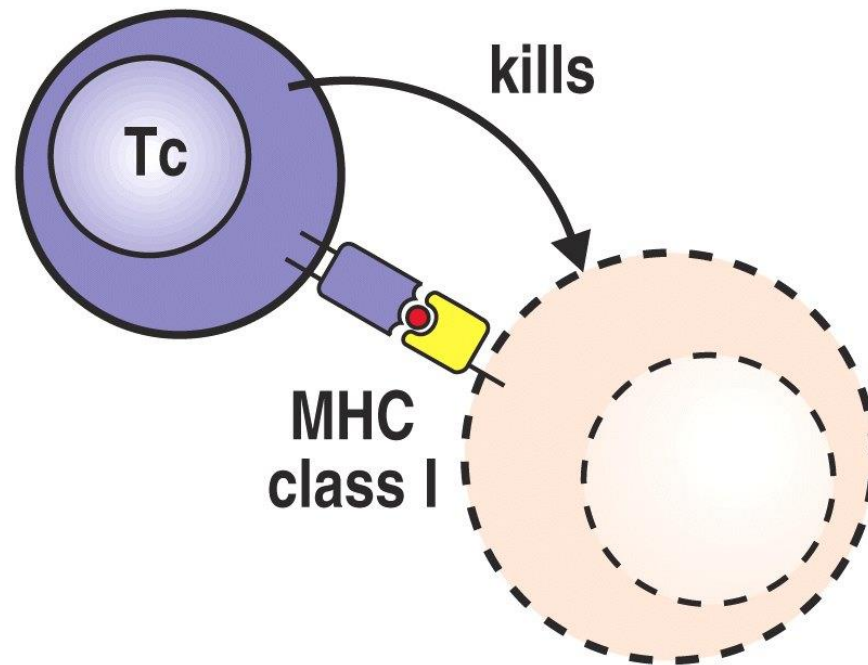


Figure 1-30 Immunobiology, 6/e. (© Garland Science 2005)

The effector function of helper T-cells (Th1)

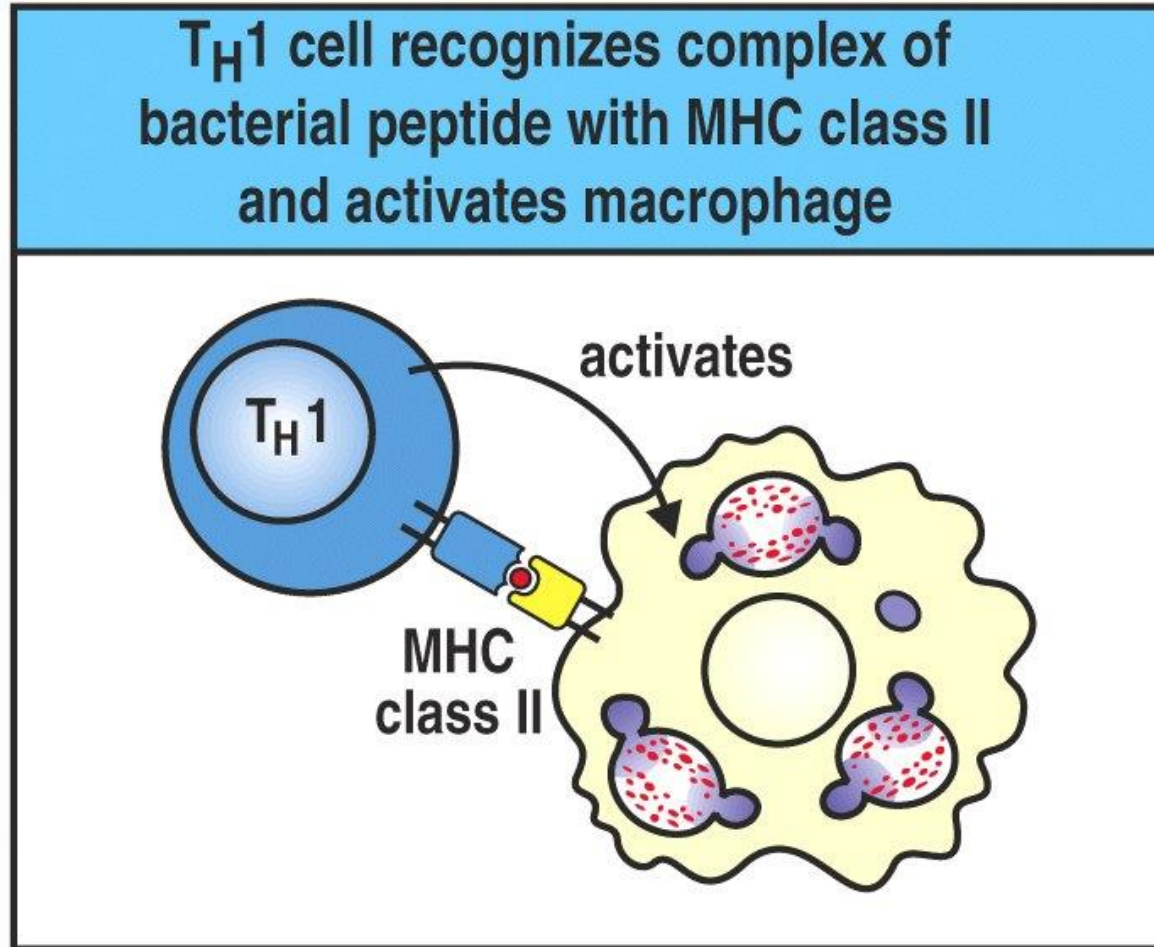
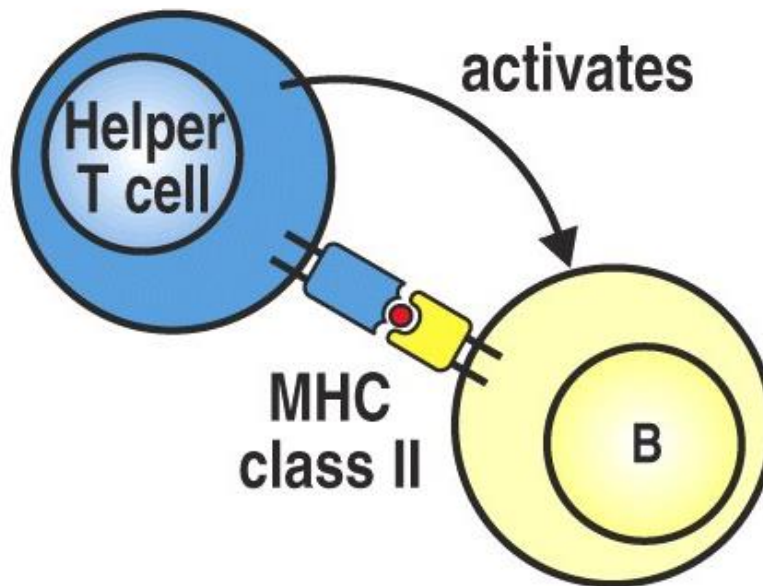


Figure 1-31 Immunobiology, 6/e. (© Garland Science 2005)

The effector function of helper T-cells (Th2)

Helper T cell recognizes complex of antigenic peptide with MHC class II and activates B cell



The structure of antibodies

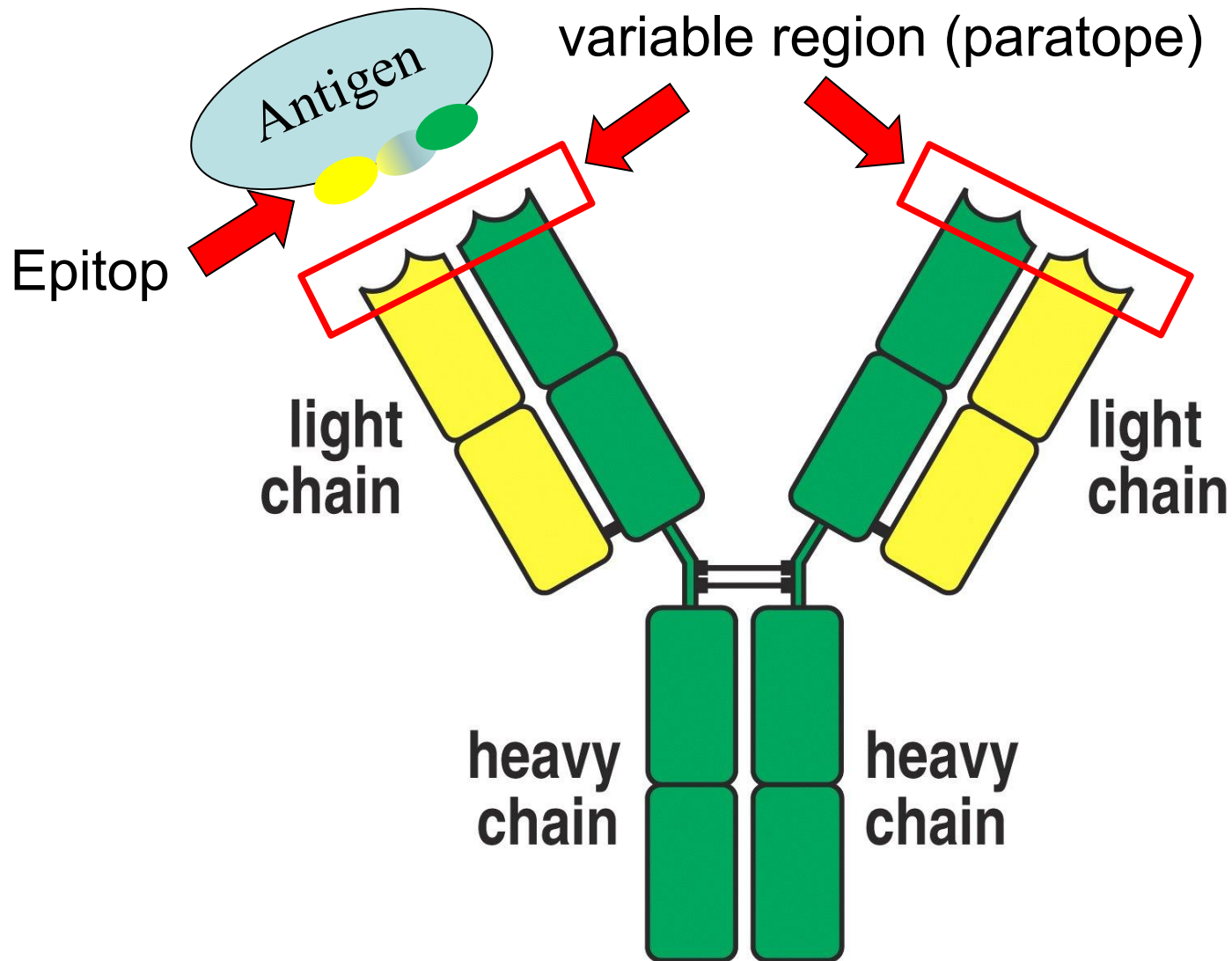


Figure 1-17 Immunobiology, 6/e. (© Garland Science 2005)

The different effector function of antibodies

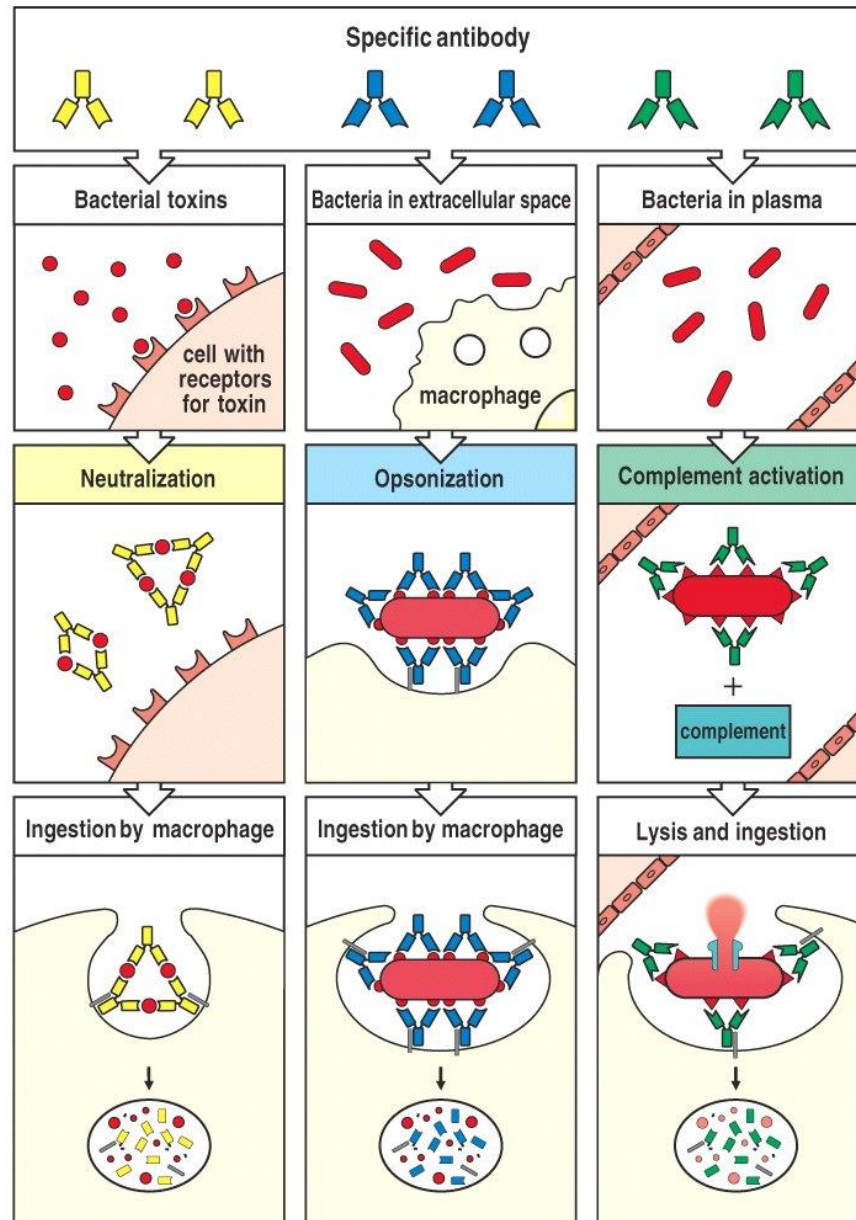


Figure 1-24 Immunobiology, 6/e. (© Garland Science 2005)

The biphasic response to antigens – immune memory

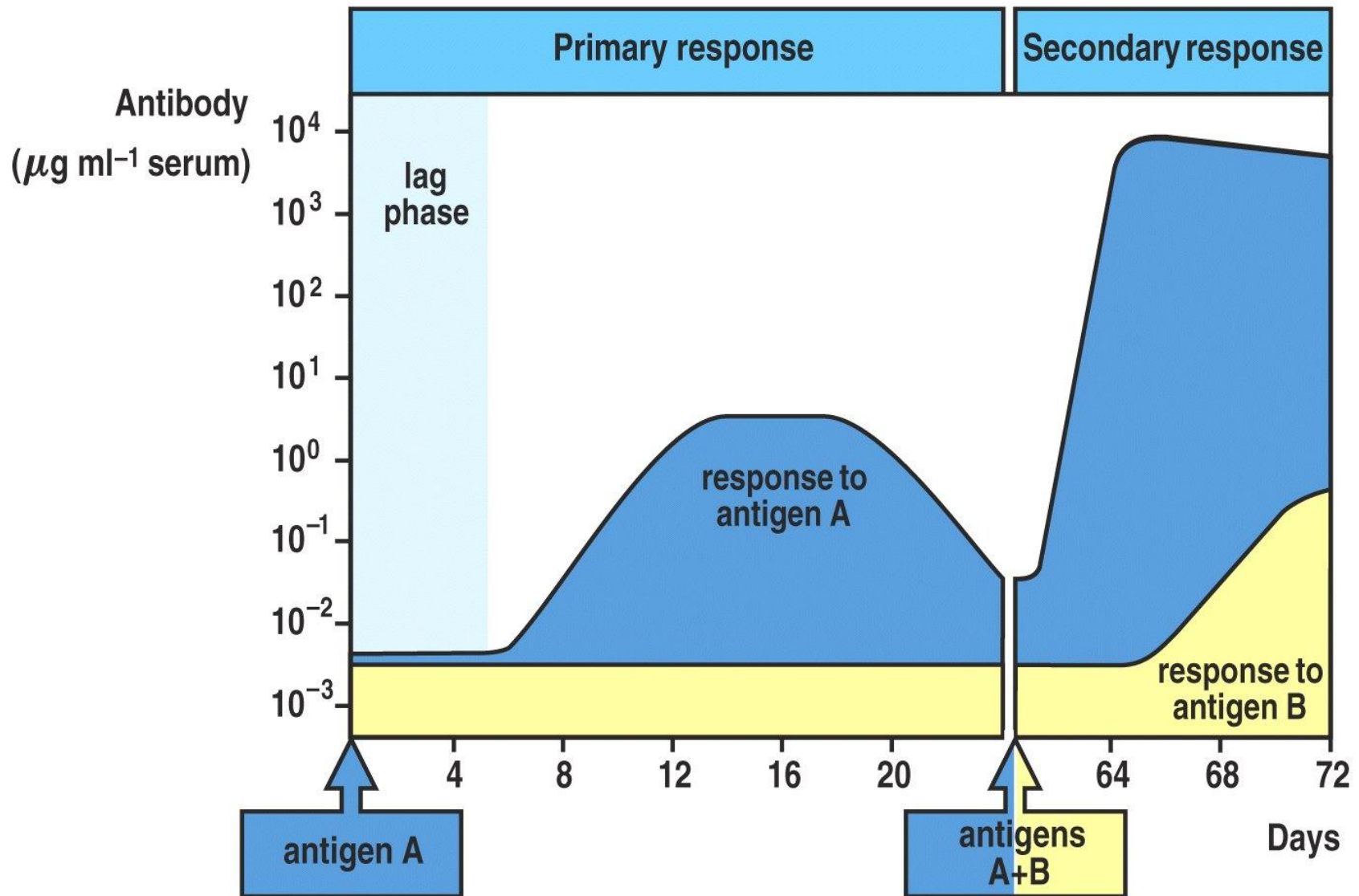


Figure 1-20 Immunobiology, 6/e. (© Garland Science 2005)