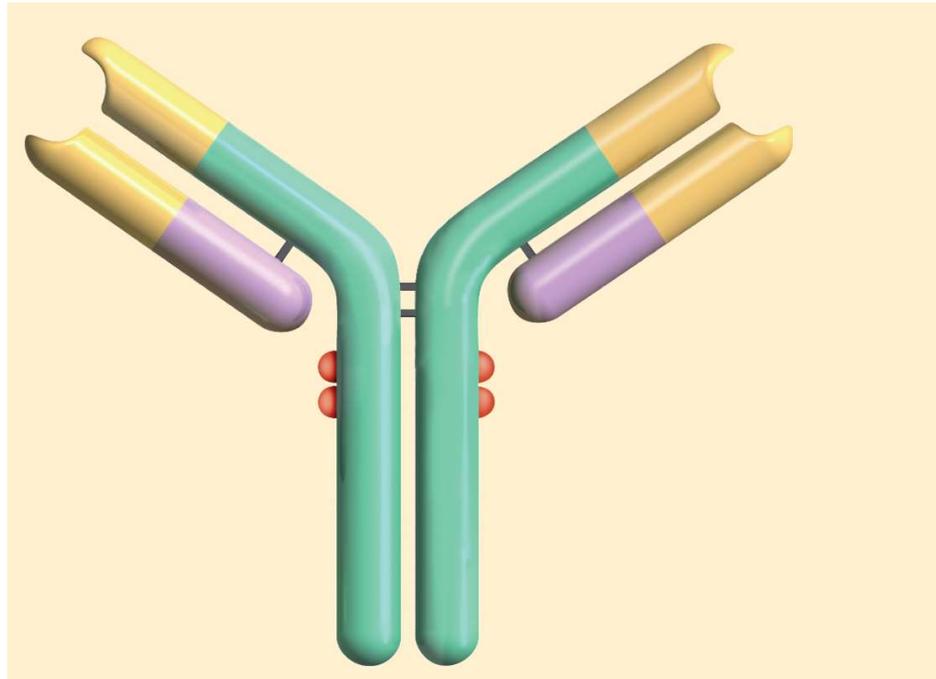


# Antibody Structure & Function

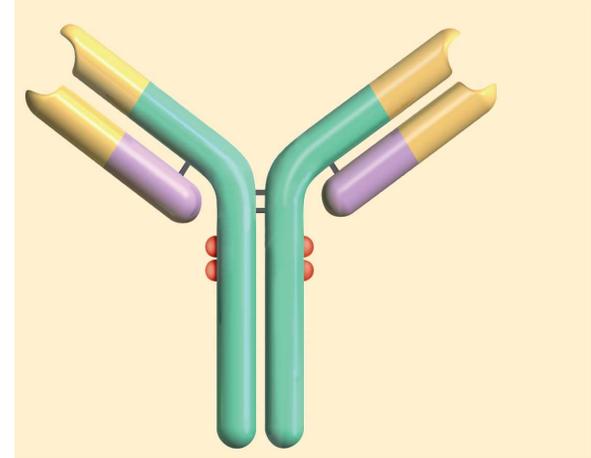


# Antibodies

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Immunoglobulin (Ig) – an antibody is a defensive gamma globulin (i.e. protein) **found in the blood plasma, tissue fluids, body secretions, and on some leukocyte membranes** /// (but not inside our cells!)

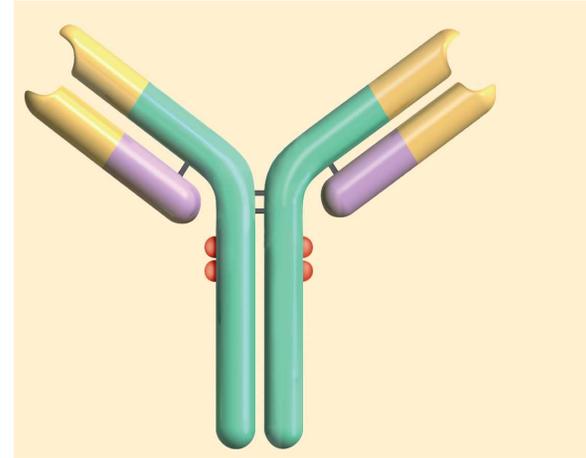
- the basic structural unit of an antibody
- composed of four polypeptide chains linked by **disulfide (-S-S-) bonds**
- two larger **heavy chains** about 400 amino acids long // heavy chains have a hinge region where antibody is bent
- two **light chains** about half as long
- **variable (V) region** in all four chains // gives the antibody its uniqueness



# Antibodies

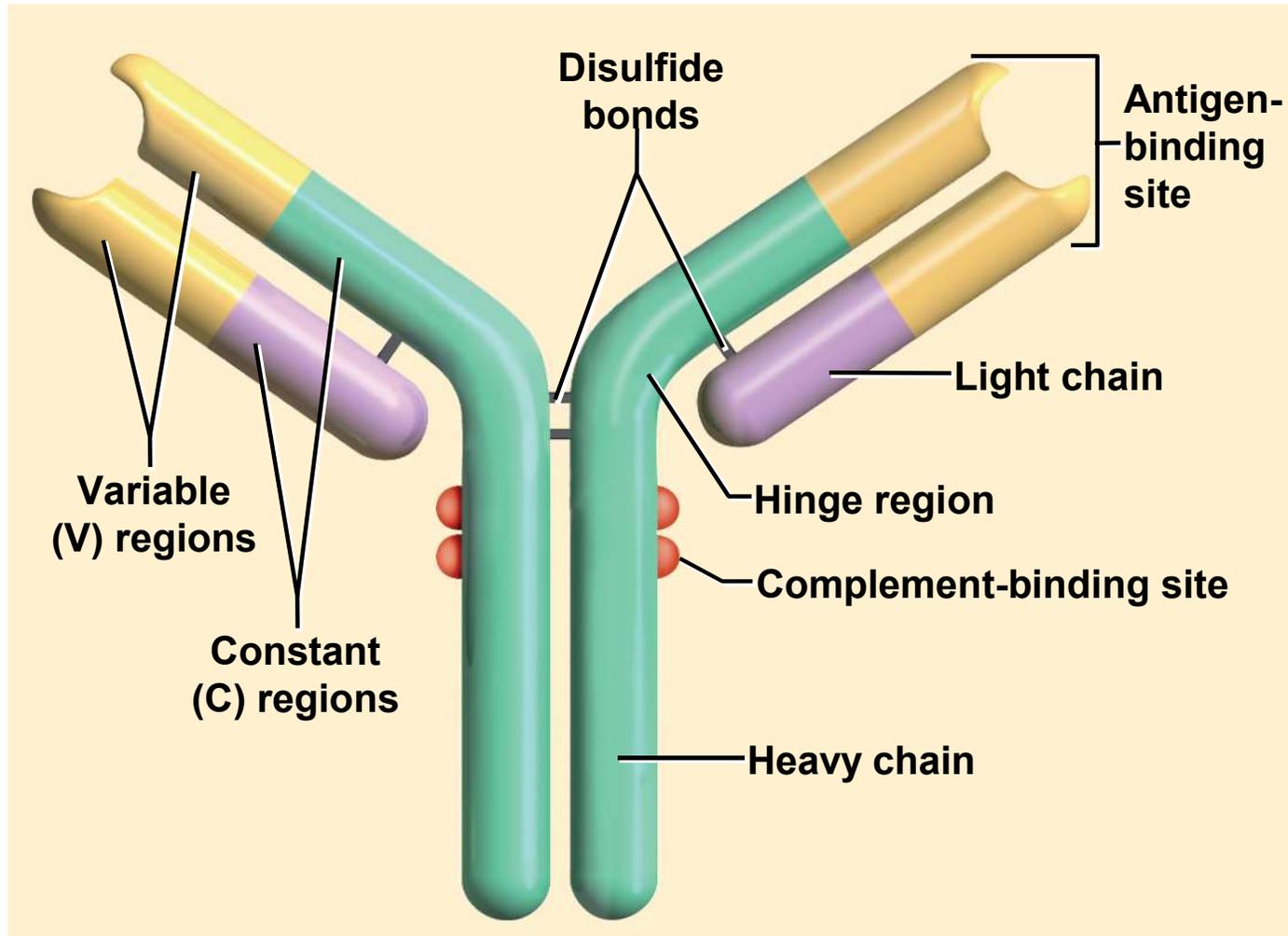
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- **antigen binding site** – formed from the V regions of the heavy and light chain on each arm // attaches to the epitope of an antigen molecule
  - Each monomer can bind to two epitopes
  - Epitopes can be on same cell or on two different cells (e.g. agglutination)
- **constant (C) region** has the same amino acid sequence within one person and determines mechanism of antibody action



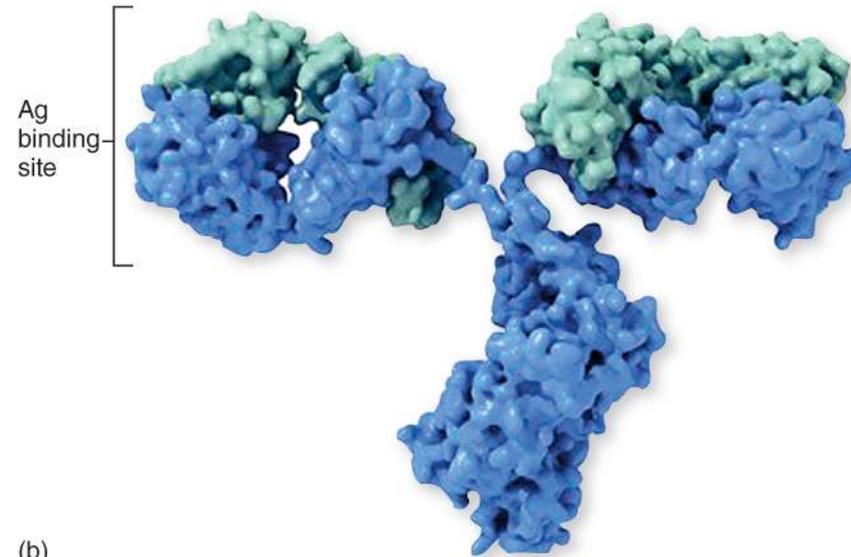
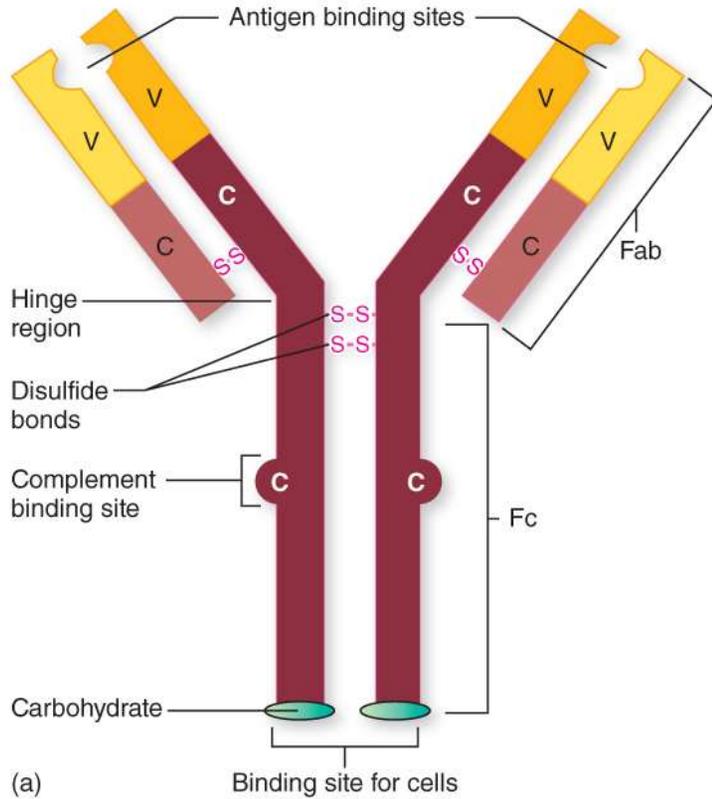
# Antibody Structure

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# Antibody Structure

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(b): U.S. National Library of Medicine

# Five Classes of Antibodies

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- Remember “**MADGE**” (IgM – IgA – IgD – IgG – IgE)
  - Note: a single plasma cell has the capacity to produce all the different classes of antibodies
  - Single plasma cells makes 2,000 antibodies per second for 7 days – clonal selection produces thousands of active plasma cells
  - A single plasma cells may start to produce IgM antibodies and then switch to produce IgG later in the infection

# Five Classes of Antibodies

---

## - Immunoglobulin M (IgM)

- pentamer in plasma and lymph
- secreted in primary immune response
- Agglutination of RBCs
- Able to activate complement ion

# Five Classes of Antibodies

---

## – Immunoglobulin A (IgA)

- Secretory dimer in **mucus, saliva, tears, milk, and intestinal secretions**
- prevents pathogen adherence to epithelia and penetrating underlying tissues
- provides passive immunity to newborns
- monomer in plasma

# Five Classes of Antibodies

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## – Immunoglobulin (IgD)

- Monomer
- B cell membrane antigen receptor
- thought to function in B cell activation by antigens

# Five Classes of Antibodies

---

## – Immunoglobulin (IgG)

- Monomer
- constitutes 80% of circulating antibodies
- crosses placenta to fetus
- secreted in secondary immune response
- Able to activate complement

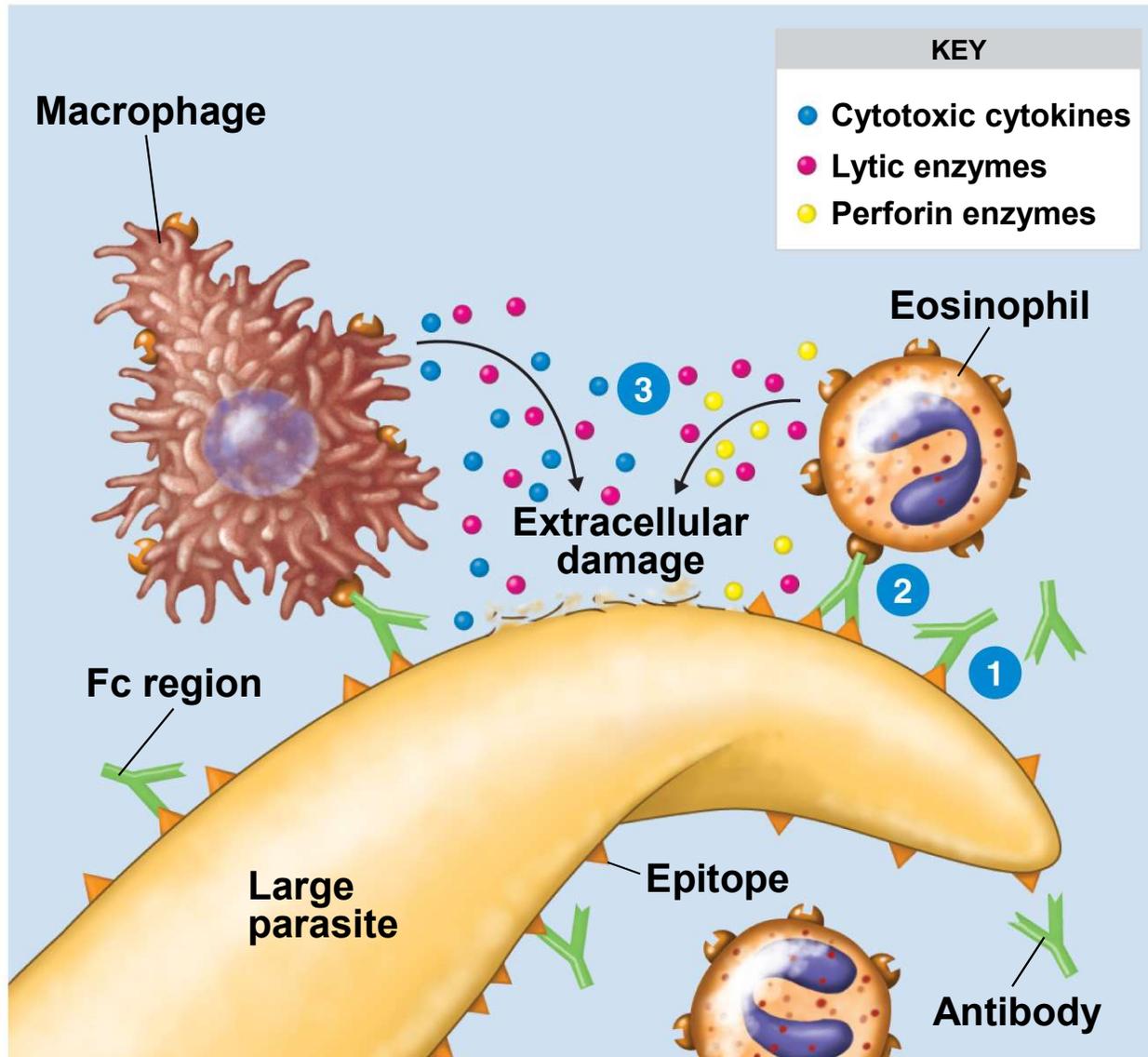
# Five Classes of Antibodies

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## – Immunoglobulin (IgE)

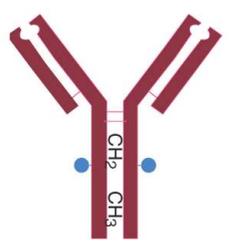
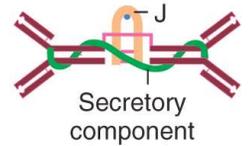
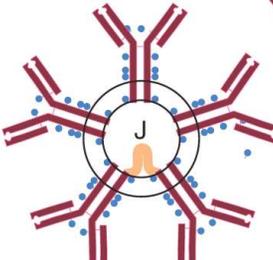
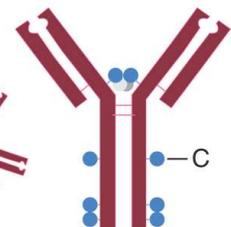
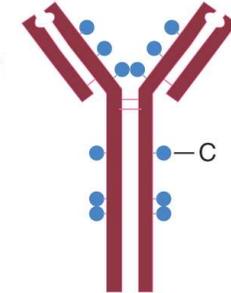
- Monomer
- transmembrane protein on basophils and mast cells
- stimulates release of histamine and other chemical mediators of inflammation and allergy // produces immediate hypersensitivity reactions
- binds to antigen on parasites // attracts eosinophils to parasitic infections // result in respiratory burst to kill parasite

## Antibody-dependent cell-mediated cytotoxicity (ADCC).



**(a)** Organisms, such as many parasites, that are too large for ingestion by phagocytic cells must be attacked externally.

**Table 13.8** Characteristics of the Immunoglobulin (Ig) Classes

	Monomer	Dimer, Monomer	Pentamer	Monomer	Monomer
	IgG	IgA	IgM	IgD	IgE
					
Number of Antigen Binding Sites	2	4, 2	10	2	2
Molecular Weight	150,000	170,000–385,000	900,000	180,000	200,000
Percentage of Total Antibody in Serum	80%	13%	6%	1%	0.002%
Average Half-Life in Serum (Days)	23	6	5	3	2.5
Crosses Placenta?	Yes	No	No	No	No
Fixes Complement?	Yes	No	Yes	No	No
Fc Binds to	Phagocytes				Mast cells and basophils
Biological Function	Monomer produced by plasma cells in a primary response and by memory cells responding the second time to a given antigenic stimulus; most prevalent antibody circulating throughout the tissue fluids and blood; neutralizes toxins, opsonizes, fixes complement	Dimer is secretory antibody on mucous membranes; monomer in small quantities in blood	Produced at first response to antigen; can serve as B-cell receptor	Receptor on B cells; triggering molecule for B-cell activation	Antibody of allergy; worm infections; mediates anaphylaxis, asthma, etc.

## What four actions are used by antibodies to defeat pathogens?

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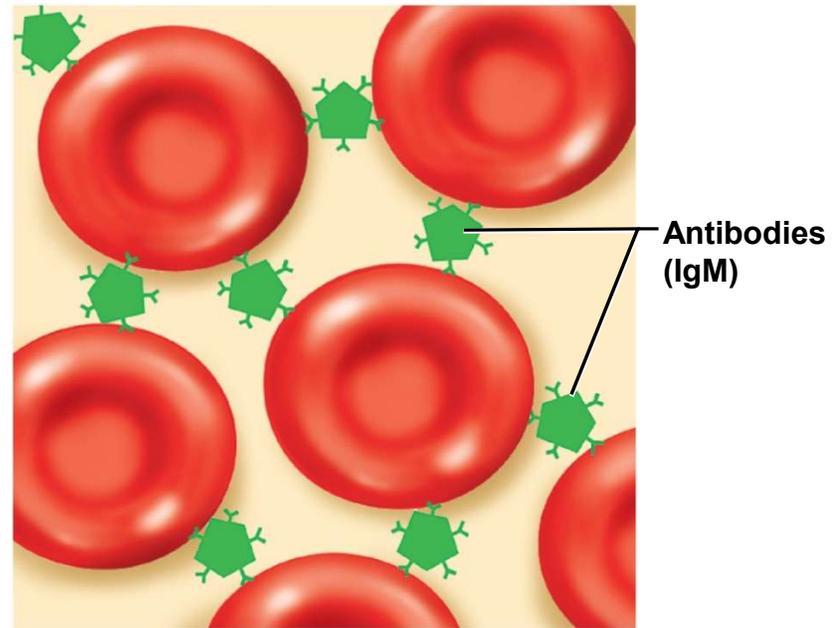
- #1) Neutralization = antibodies mask pathogenic region of antigen
- #2) Complement fixation
  - antigen binds to IgM or IgG, antibody changes shape, initiates complement binding which leads to inflammation, phagocytosis, immune clearance, or cytolysis
  - primary defense against foreign cells, bacteria, and mismatched RBCs

# What are the four actions used by antibodies to defeat pathogens?

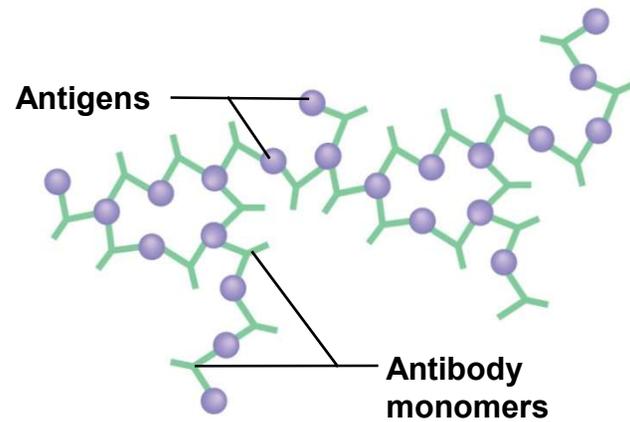
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- #3) Agglutination // antibody has 2-10 binding sites
  - binds to multiple enemy cells immobilizing them from spreading
- #4) Precipitation // antibody binds antigen molecules (not cells)
  - creates antigen-antibody complex that precipitates // potentially dangerous because falls in between epithelial cells //
  - IgG and IgM able to initiate complement within membranes which may destroy surrounding tissue
  - Ag-Ab complex normally phagocytized by eosinophils or immune clearance mediated by C3b-RBC-Ag-Ab complex carried to spleen's macrophage

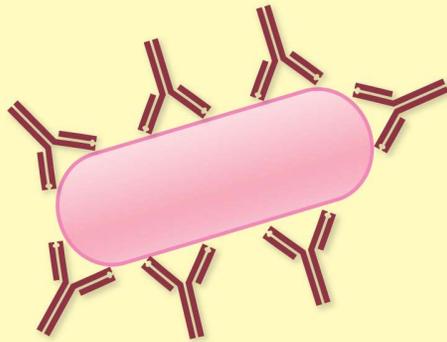
# Agglutination



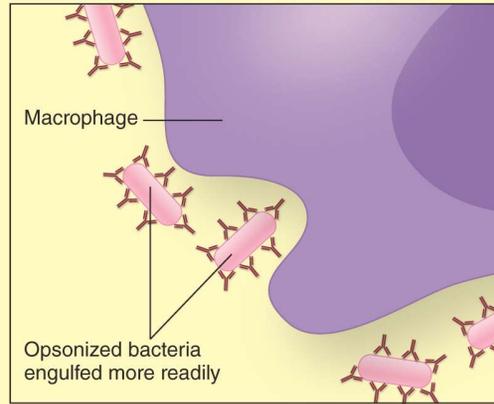
(a)



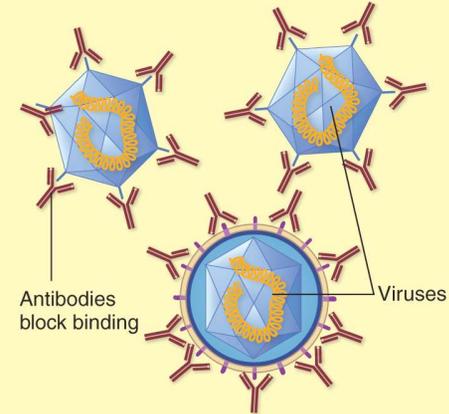
**Table 13.7** Summary of Antibody Functions



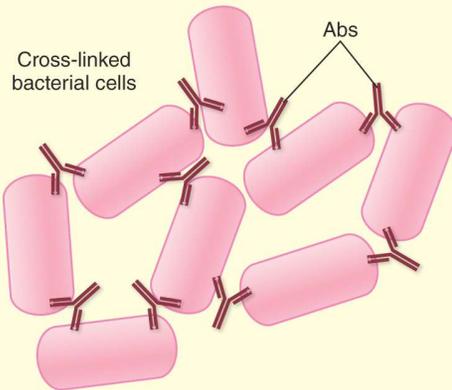
Antibodies coat the surface of a bacterium, preventing its normal function and reproduction in various ways.



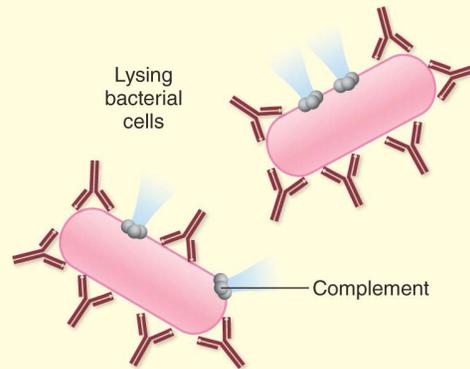
Antibodies called opsonins stimulate **opsonization** (ahp<sup>oo</sup>-son-uh-zaz'-shun), a process that makes microbes more readily recognized by phagocytes, which dispose of them. Opsonization has been likened to putting handles on a slippery object to provide phagocytes a better grip.



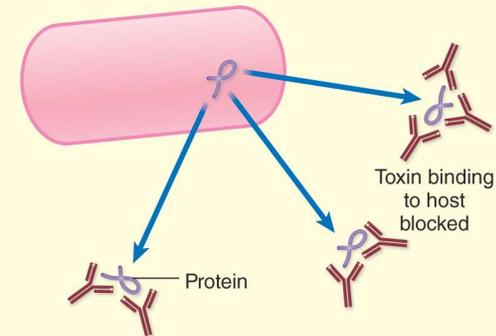
In **neutralization** reactions, antibodies fill the surface receptors on a virus or the active site on a microbial enzyme to prevent it from attaching normally.



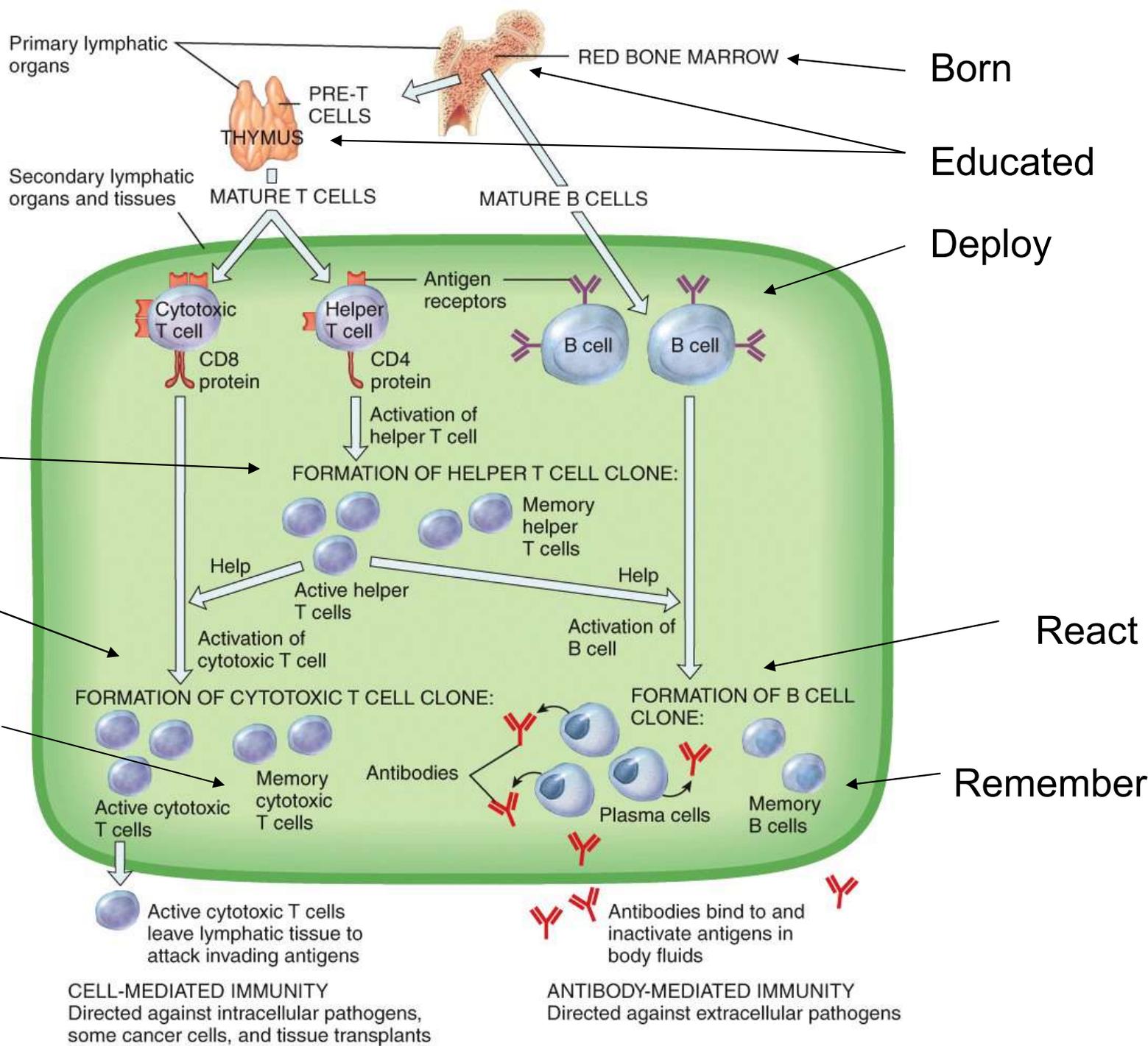
The capacity for antibodies to aggregate, or **agglutinate**, antigens is the consequence of their cross-linking cells or particles into large clumps. Agglutination renders microbes immobile and enhances their phagocytosis. This is a principle behind certain immune tests discussed in chapter 15.



The interaction of an antibody with complement can result in the specific rupturing of cells and some viruses.



An **antitoxin** is a special type of antibody that neutralizes bacterial exotoxins.



# What is the difference between a primary & secondary humoral response?

---

- Primary immune response – immune reaction brought about by the first exposure to an antigen
  - appearance of protective antibodies delayed for 3 to 6 days while naïve B cells multiply and differentiate into plasma cells
  - as plasma cells produce antibodies, the **antibody titer** (level in the blood plasma) rises
    - IgM appears first, peaks in about 10 days, soon declines
    - IgG levels rise as IgM declines, but IgG titer drops to a low level within a month

# What is the difference between a primary & secondary humoral response?

---

- primary response leaves one with an immune memory of the antigen
  - during clonal selection, some of the clonal becomes memory B cells
  - found mainly in germinal centers of the lymph nodes
  - memory cells able to mount a very quick secondary response // matter of hours not days!

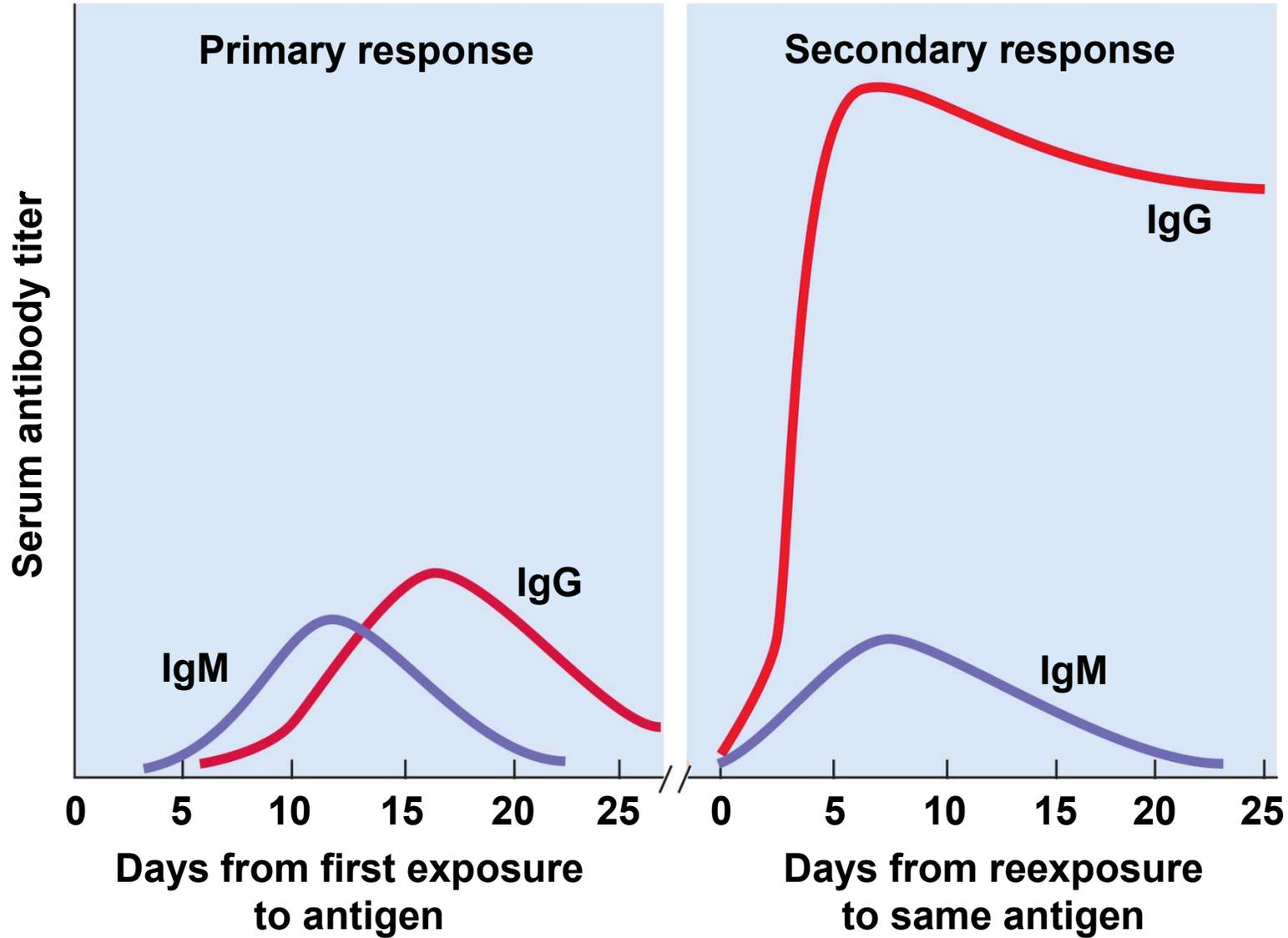
# What is secondary humoral immunity?

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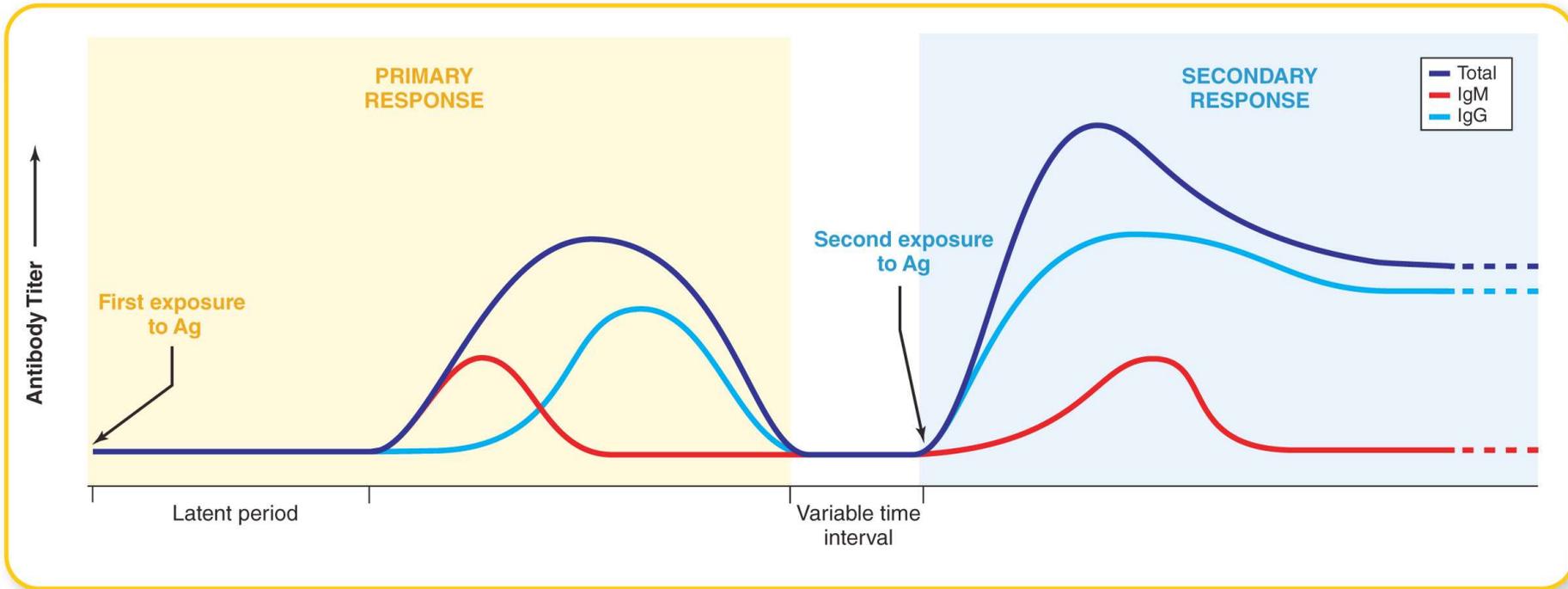
- Occurs when re-exposed to the same antigen
- plasma cells form within hours
- IgG titer rises sharply and peaks in a few days
- response is so rapid that the antigen has little chance to exert a noticeable effect on the body
- no illness results
- low levels of IgM also secreted and quickly declines
- IgG remain elevated for weeks to years // conferring long lasting protection
- The “memory function” does not last as long in humoral immunity as it does in cellular immunity

# Humoral Immunity Responses

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**Table 13.9** Primary and Secondary Response to Antigens



Upon the first exposure to an antigen, the system undergoes a **primary response**. The earliest part of this response, the *latent period*, is marked by a lack of antibodies for that antigen, but much activity is occurring. During this time, the antigen is being concentrated in lymphoid tissue and is being processed by the correct clones of B lymphocytes. As plasma cells synthesize antibodies, the serum titer increases to a certain plateau and then tapers off to a low level over a few weeks or months. Early in the primary response, most of the antibodies are the IgM type, which is the first class to be secreted by plasma cells. Later, the class of the antibodies (but not their specificity) is switched to IgG or some other class (IgA or IgE).

After the initial response, there is no activity, but memory cells of the same specificity are seeded throughout the lymphatic system.

When the immune system is exposed again to the same immunogen within weeks, months, or even years, a **secondary response** occurs. The rate of antibody synthesis, the peak titer, and the length of antibody persistence are greatly increased over the primary response. The speed and intensity seen in this response are attributable to the memory B cells that were formed during the primary response. The secondary response is also called the **anamnestic response**. The advantage of this response is evident: It provides a quick and potent strike against subsequent exposures to infectious agents.

# How may the adaptive immunity response vary between different people?

---

- Immune responses may be:
  - **Just right** / maintains healthy state
  - **Too vigorous** = hypersensitivity (e.g. Anaphylactic shock)
  - **Too weak** = immunodeficiency disease (e.g. AIDS)
  - **Misdirected** against wrong target cells = autoimmune diseases (i.e. Type 1 diabetes)