

Antibody-mediated Immunity

Immunology Unit
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KSU

Reference
Kuby Immunology 7th Edition
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Chapter 13 Pages 416-423
Chapter 3 Pages 80-90

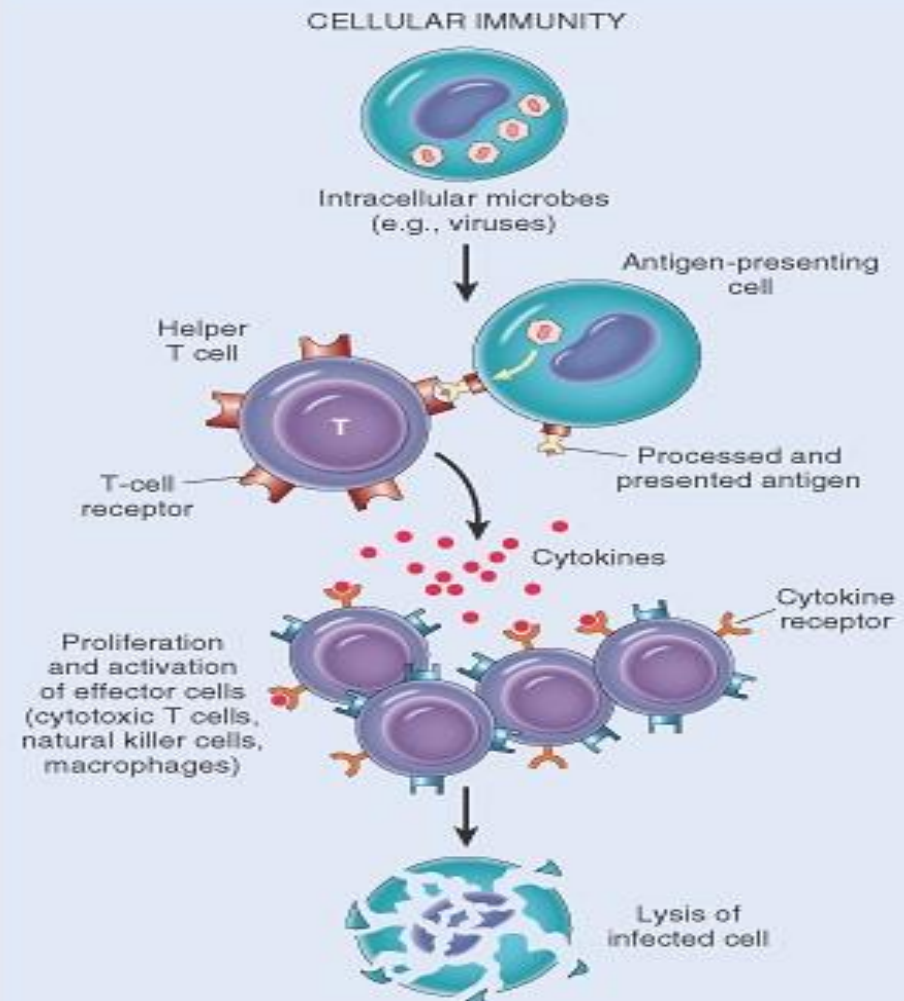
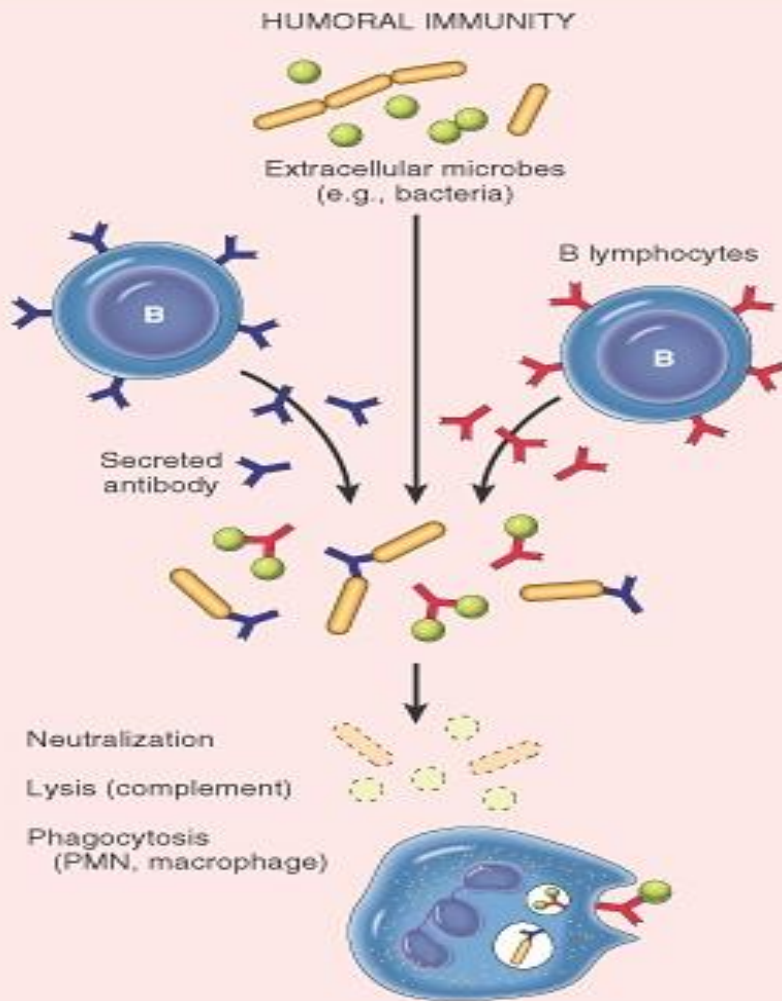
Objectives

1. To describe B-cells as the mediators of humoral immunity, (antibody-mediated immunity)
2. To describe activation of B-cells which involve:
 - Antigen recognition
 - T-dependent & T-independent antigens
 - Requirement for T-helper cells
3. To explain clonal selection, clonal expansion & generation of plasma cells & memory cells
4. To describe primary & secondary immune responses
5. To describe the structure & function of Immunoglobulins

Humoral immunity is so named because it involves substances found in the:
humours or body fluids

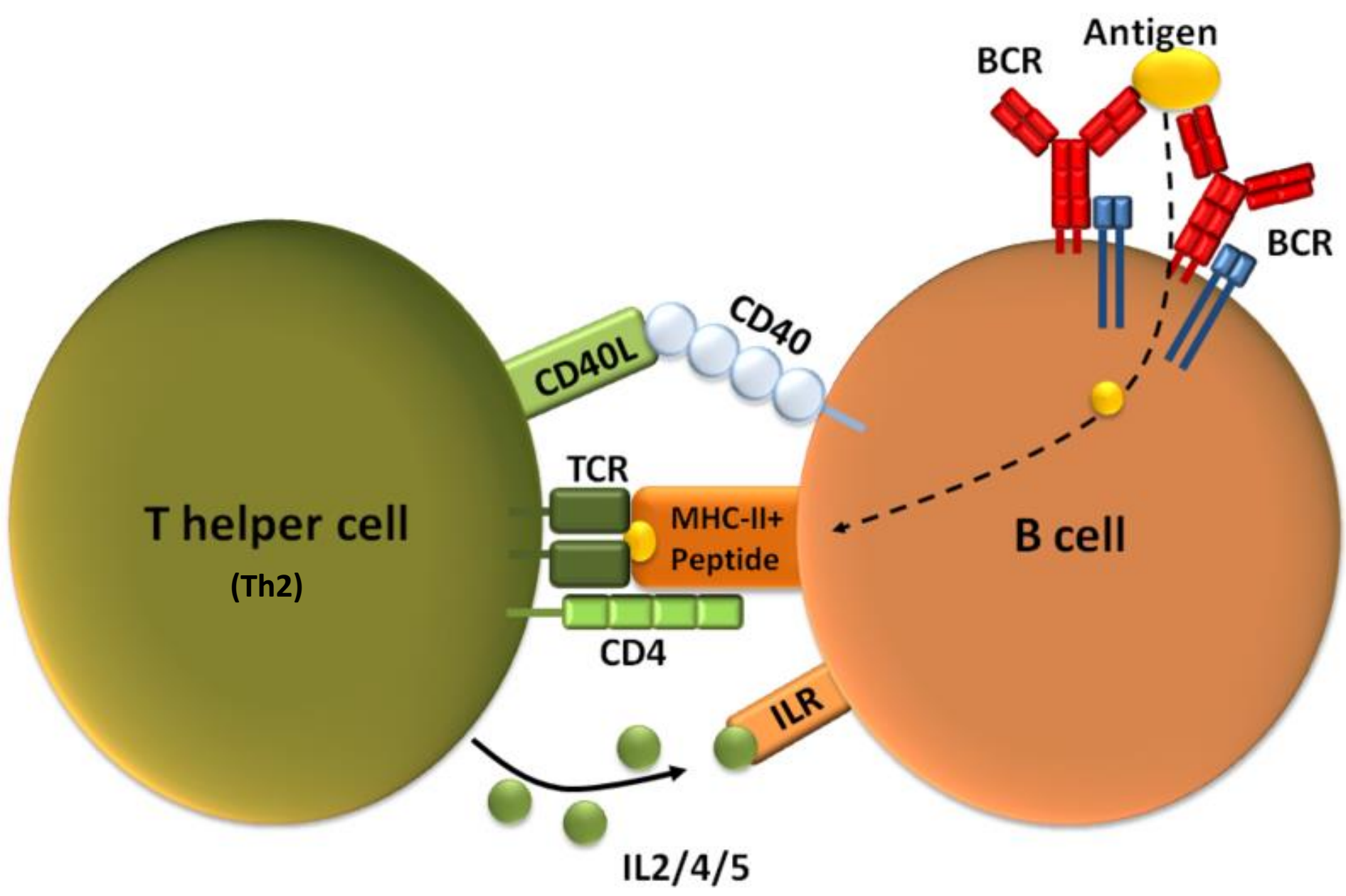
- The **Humoral Immune Response** is the aspect of immunity that is mediated by secreted **antibodies**

Nature of antigen determine type of response either **EXTRACELLULAR** or **INTRACELLULAR**

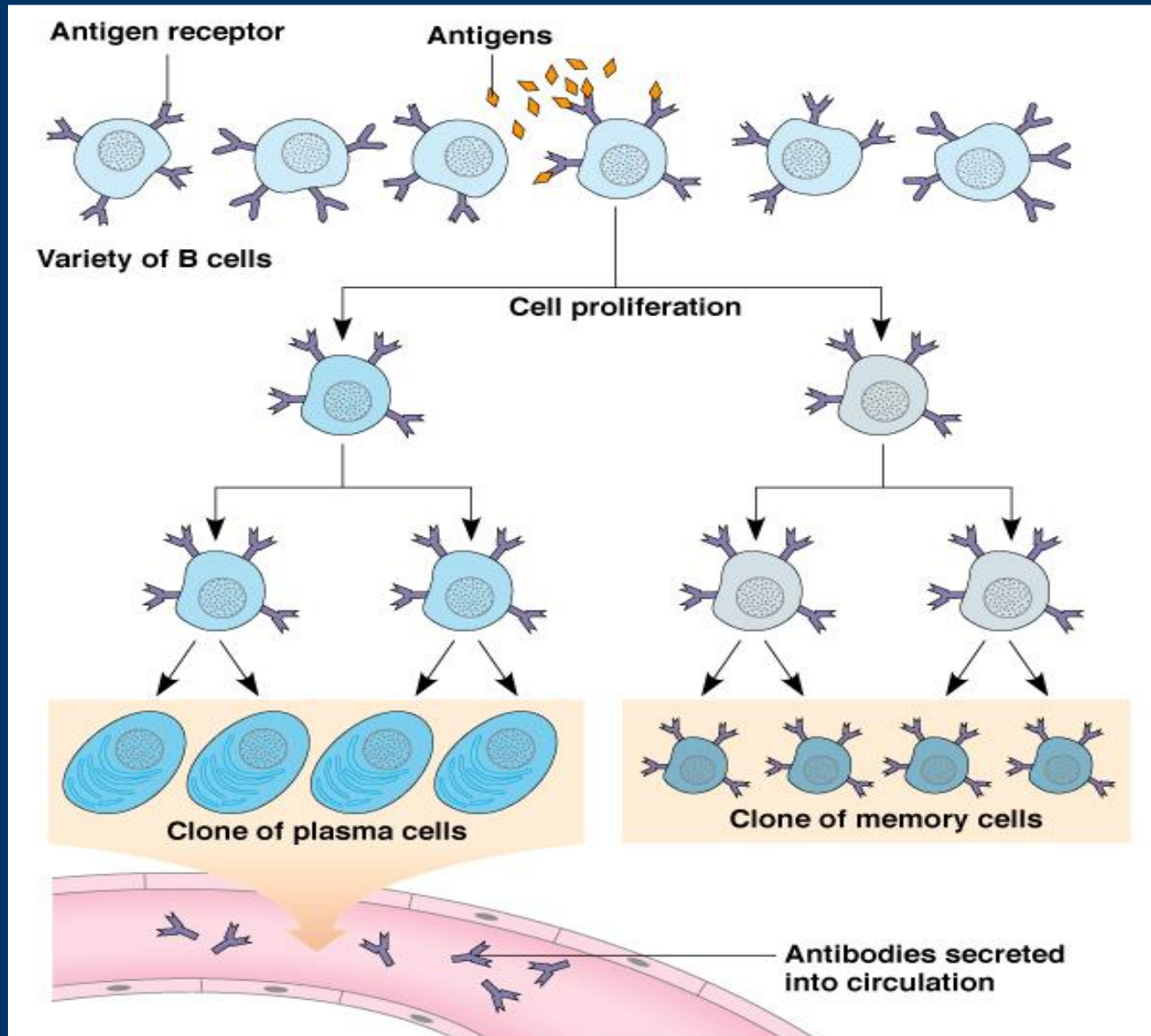


Activation of B cells by antigens

- Two types of antigens:
- **1. T-dependant :**
 - Antibody production by B-cells **require** T-helper cells
 - Antigen presenting cells recognize antigen & present it to T-helper cells
 - T-helper cells stimulate B-cells specific for that antigen to become **plasma cells**
 - T-dependant antigens are mainly **proteins** on viruses, bacteria & other foreign materials.



Clonal selection and clonal proliferation



2. T- independent antigens

1. B-cells **do not** require T-helper cells to produce antibody.
2. Antigens are mainly **polysaccharides or lipopolysaccharides** with repeating subunits (bacterial capsules).
3. Immune responses induce the production of **IgM of low affinity** for the antigen and **no immunologic memory**

Antibodies

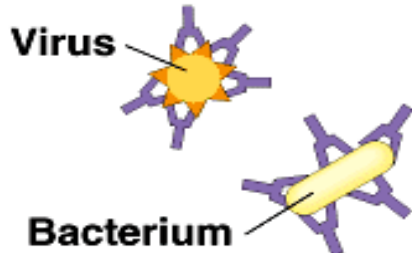
- Antibodies are immunoglobulins with specific functions
- Antibodies bind to specific sites on antigen surfaces called epitopes and perform protective functions by different mechanisms

There is a SPECIFIC antibody for any one given type of an antigen

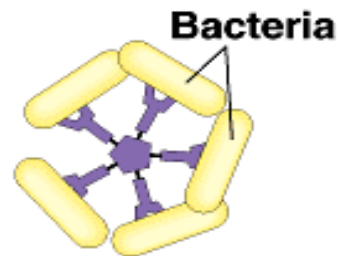
Protective functions of antibodies

Binding of antibodies to antigens inactivates antigens by

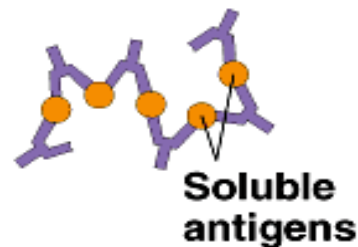
Neutralization
(blocks viral binding sites;
coats bacteria and/or
opsonization)



**Agglutination of
antigen-bearing
particles, such as
microbes**



**Precipitation of
soluble antigens**

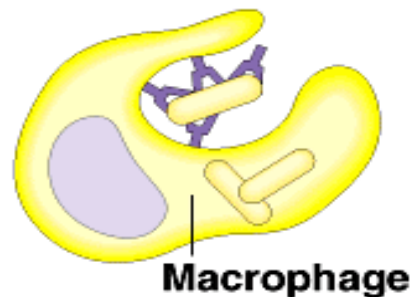


**Complement fixation
(activation
of complement)**



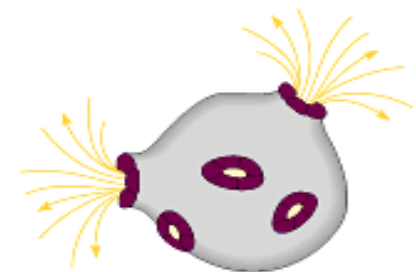
Enhances

Phagocytosis



Leads to

Cell lysis



Electron micrographs of the effect of antibodies and complement upon bacteria



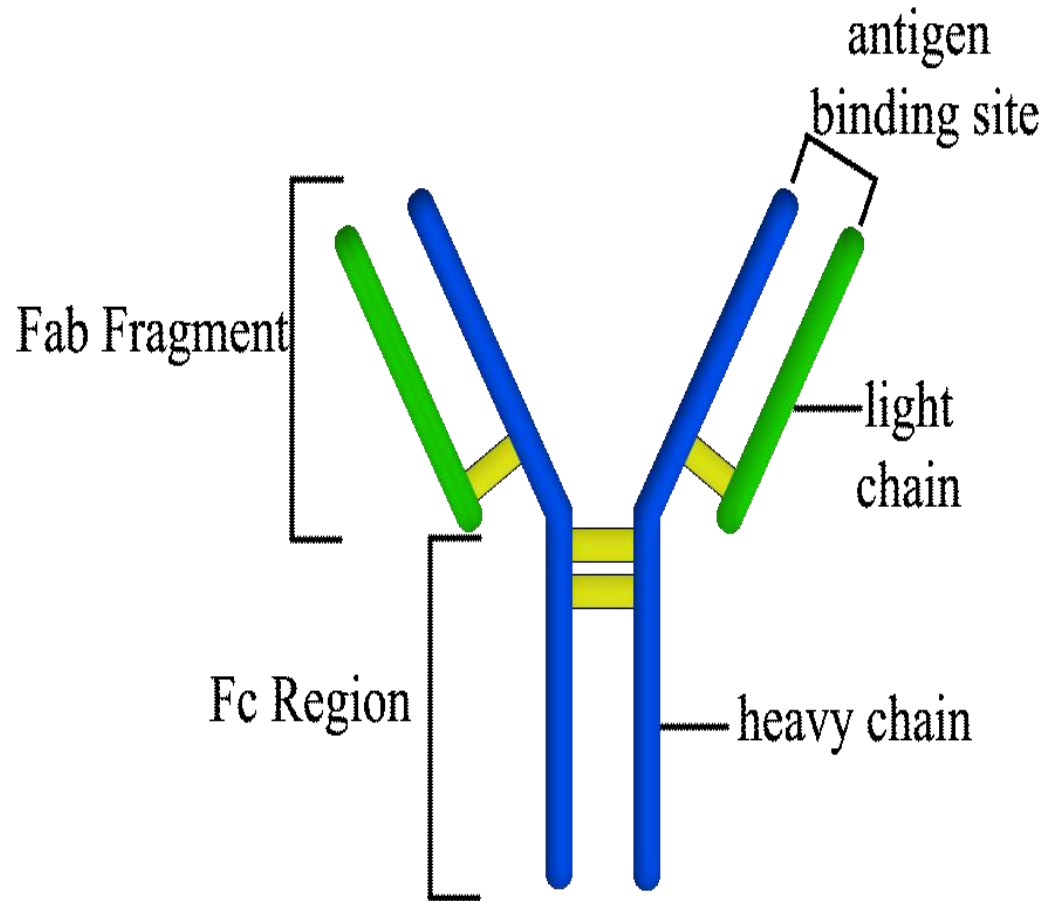
Healthy E. coli



Antibody + complement-mediated damage to E. coli

Antibody structure and functions

1. Made up of four polypeptides chains
2. Two longer and larger (heavy chains) and the other two shorter and smaller (light chains)
3. Have the shape of a letter “Y”




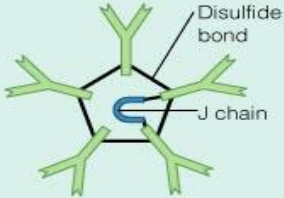
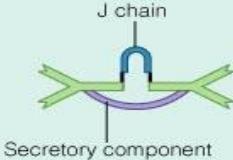


- Variable region has the potential to bind with particular classes of antigens

Once a raw antibody is stimulated to fit to a specific antigen, it can then react with **ONLY** that antigen

This is known as **SINGLE SPECIFICITY**

- Can fit as precisely as a lock-and-key to an antigen

A Summary of Immunoglobulin Classes

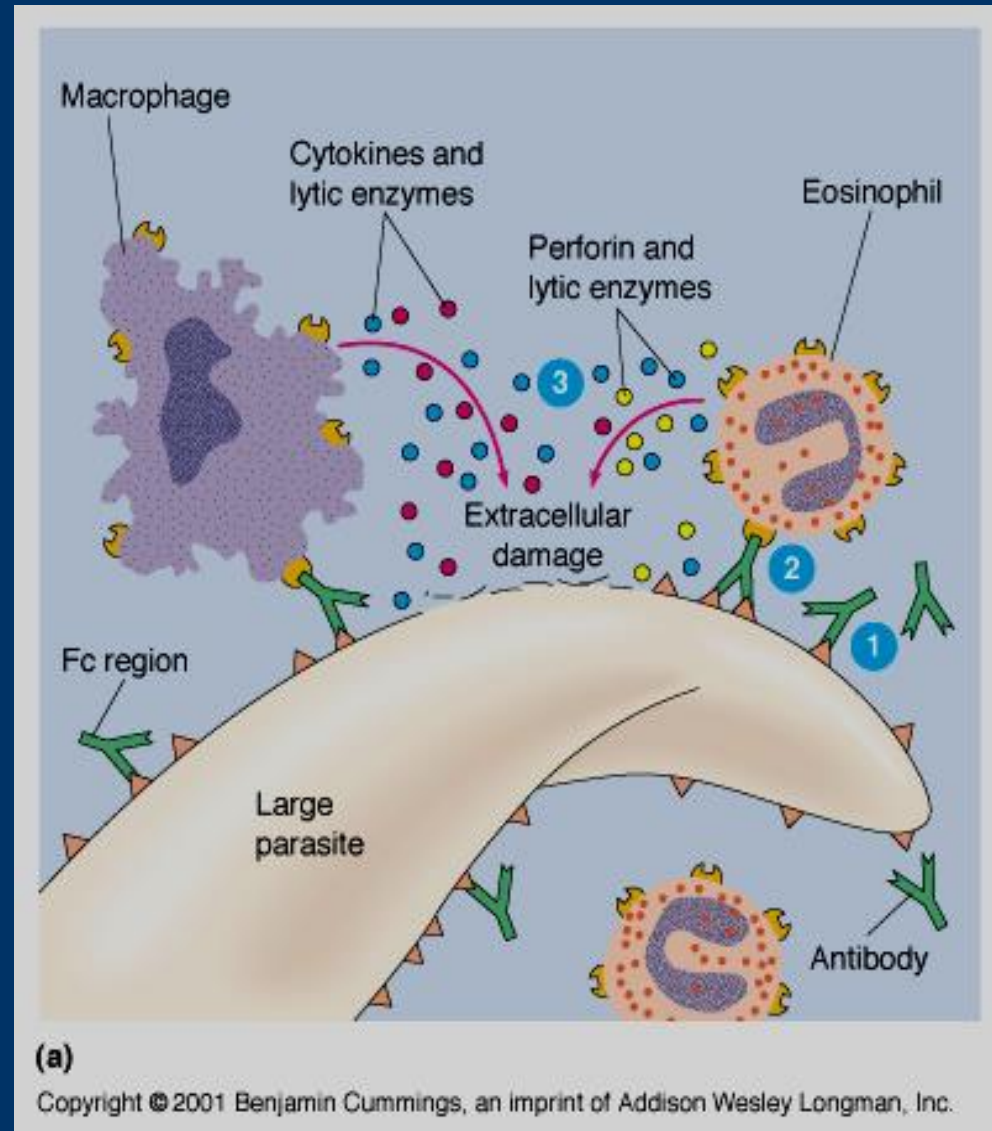
Characteristics	IgG	IgM	IgA	IgD	IgE
					
Structure	Monomer	Pentamer	Dimer (with secretory component)	Monomer	Monomer
Percentage of total serum antibody	80%	5–10%	10–15%*	0.2%	0.002%
Location	Blood, lymph, intestine	Blood, lymph, B cell surface (as monomer)	Secretions (tears, saliva, mucus, intestine, milk), blood, lymph	B cell surface, blood, lymph	Bound to mast and basophil cells throughout body, blood
Molecular weight	150,000	970,000	405,000	175,000	190,000
Half-life in serum	23 days	5 days	6 days	3 days	2 days
Complement fixation	Yes	Yes	No [†]	No	No
Placental transfer	Yes	No	No	No	No
Known functions	Enhances phagocytosis; neutralizes toxins and viruses; protects fetus and newborn	Especially effective against microorganisms and agglutinating antigens; first antibodies produced in response to initial infection	Localized protection on mucosal surfaces	Serum function not known; presence on B cells functions in initiation of immune response	Allergic reactions; possibly lysis of parasitic worms

*Percentage in serum only; if mucous membranes and body secretions are included, percentage is much higher.

[†] May be yes via alternate pathway.

Functions of Antibodies

- Antibody dependent cell-mediated cytotoxicity
 - Antibodies coat infecting cell (large parasite usually) - FC facing outwards
 - NK (lysing ability), Macrophage, neutrophils, and eosinophils have receptors for FC region of antibody
 - Secretion of lytic enzymes to destroy parasite



Functions of Antibodies

- **Opsonisation and phagocytosis**

Antibodies coat infecting cells and facilitate their phagocytosis by cells possessing Fc Receptors

- **Complement activation**

- Classical pathway, after binding to antigen
- IgM and IgG1 > IgG3 > IgG2

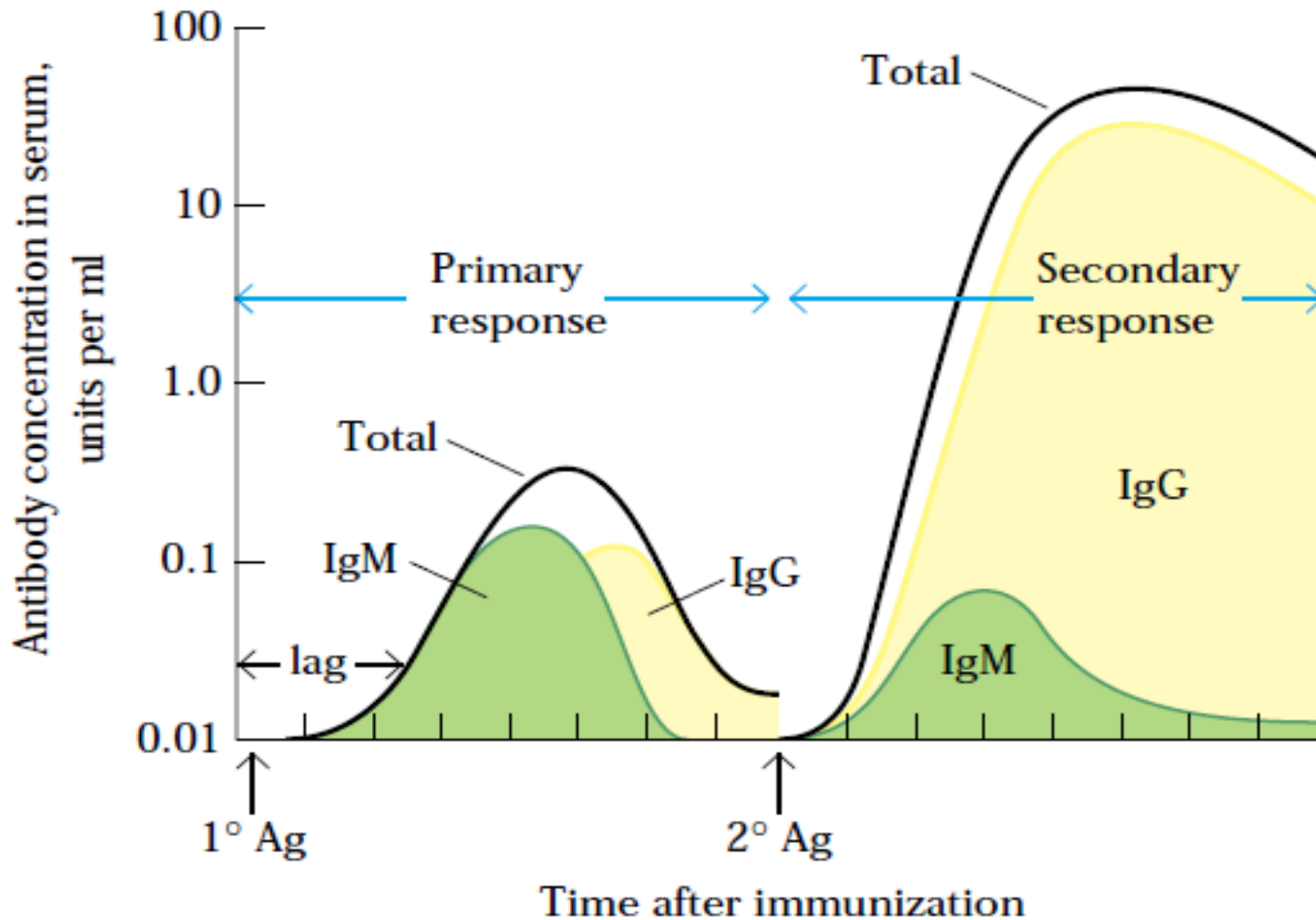
- **Transplacental transfer**

IgG

Primary & Secondary immune responses

- Initial encounter with antigen produce **primary immune response**
- Subsequent challenge with same antigen produces **secondary immune response**

Concentration & type of antibody in primary & secondary immune responses



Comparison between primary & secondary responses

Property	Primary response	Secondary response
Responding B cell	Naive (virgin) B cell	Memory B cell
Lag period following antigen administration	Generally 4–7 days	Generally 1–3 days
Time of peak response	7–10 days	3–5 days
Magnitude of peak antibody response	Varies depending on antigen	Generally 100–1000 times higher than primary response
Isotype produced	IgM predominates early in the response	IgG predominates

Take Home Message

- B cells can be activated by antigen to produce antibodies either with the assistance of helper T cells or directly by the antigen itself
- Antibodies are made up of two heavy and two light amino acid chains and have a shape of letter “Y”
- Different types of antibodies are located at various sites to provide protection by agglutination, precipitation, complement fixation etc.
- Secondary humoral immune response is swift and a stronger immune response mediated by IgG class of antibodies because of the memory cells.