MEDICINE
KING SAUD UNIVERSITY

Foundation Block

Lecture four

Antibody mediated immunity

IMMUNOLOGY

436's TEAMWORK

Objectives:

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

- **Important.**
- **Extra notes.**
- **Females notes**
- **Males notes.**

Immune system:

Adaptive:

1- Humoral Immunity:
B lymphocyte

What the lecture is going to talk about about

2- Cellular Immunity:
T lymphocyte:
- Th (helper)
- Tc (cytotoxic)

Characteristics of Adaptive Immunity:
- Antigenic specificity.
- Diversity, can recognize billion different antigens.
- Immunological memory
- Self vs non-self recognition

Innate:

Body's first line of defence.

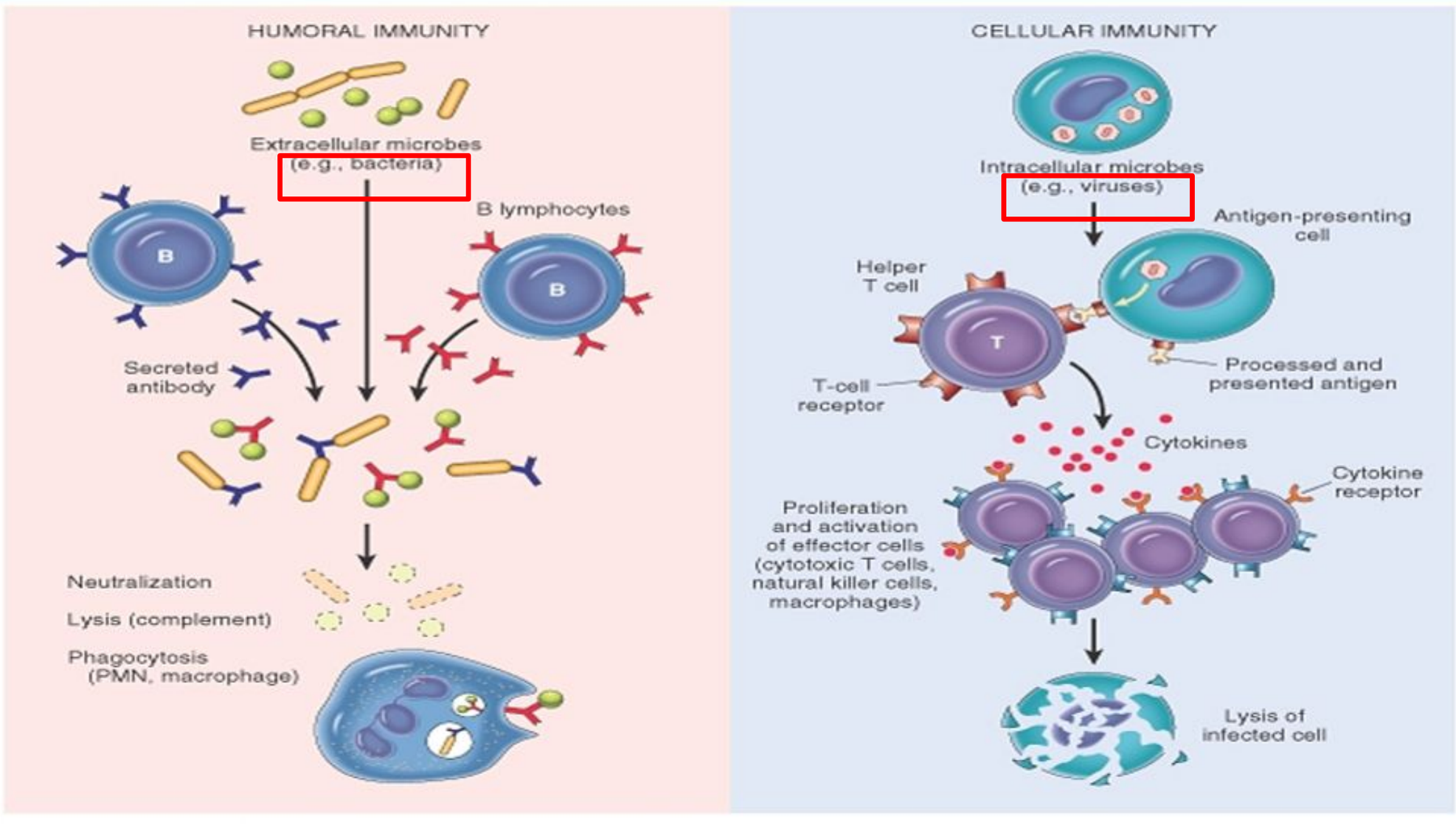
- Phagocytes
  - Neutrophils
  - Monocytes/Macrophage
  - Natural Killer
- Interferon
- Chemokine
- Tumor Necrosis Factors (TNF) Interleukin (IL)
- Complement System

Humoral immunity

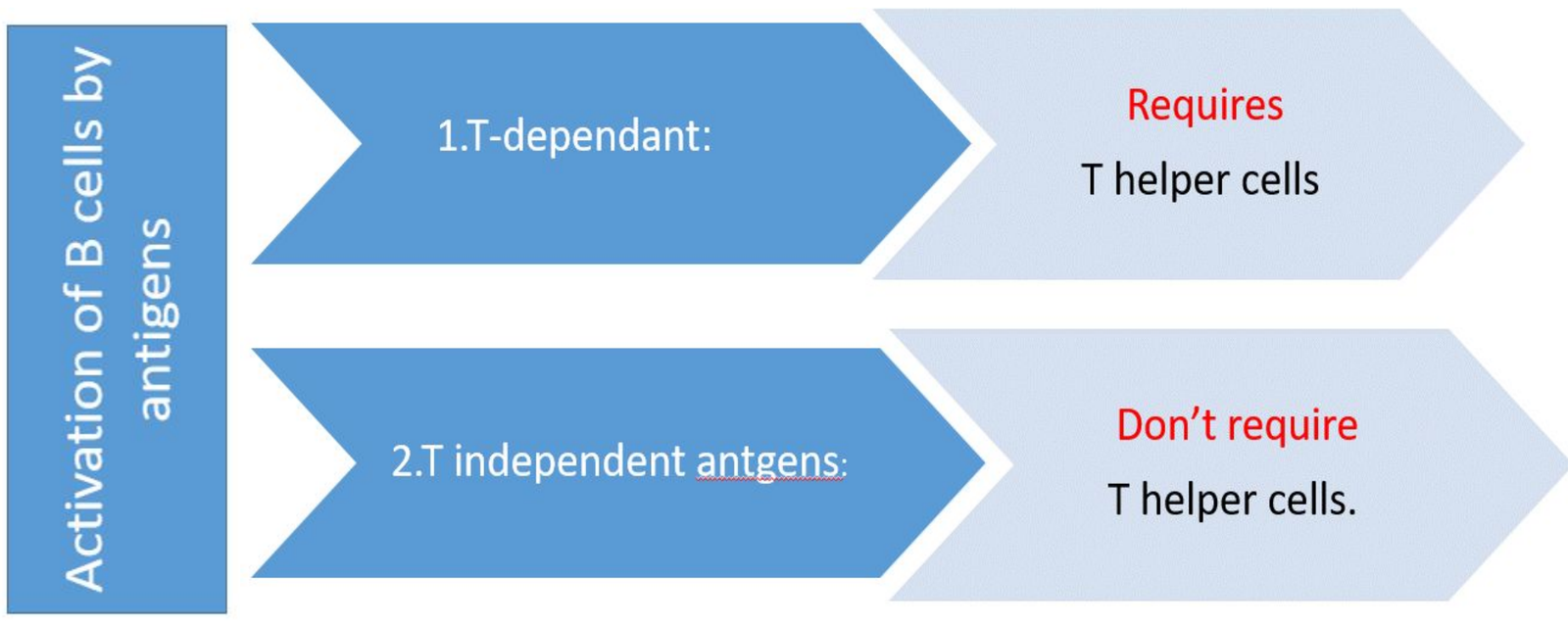
Humoral Immunity:

- Humoral immunity is so named because it involves substances found in the **humours or body fluids.**
- The **Humoral Immune Response** (antibody mediated immune) is the aspect of immunity that is mediated by secreted **antibodies**

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



Note: The bacteria or virus has antigen on its surface. If the bacteria or the virus is **outside the cell** (usually bacteria) then the cell will defend itself using **humoral immunity** and in this case it is called (**extracellular response**).
But if it was **inside the cell** (usually virus) will defend using **cellular immunity** ((review the previous lecture)) and it's called (**Intracellular response**).



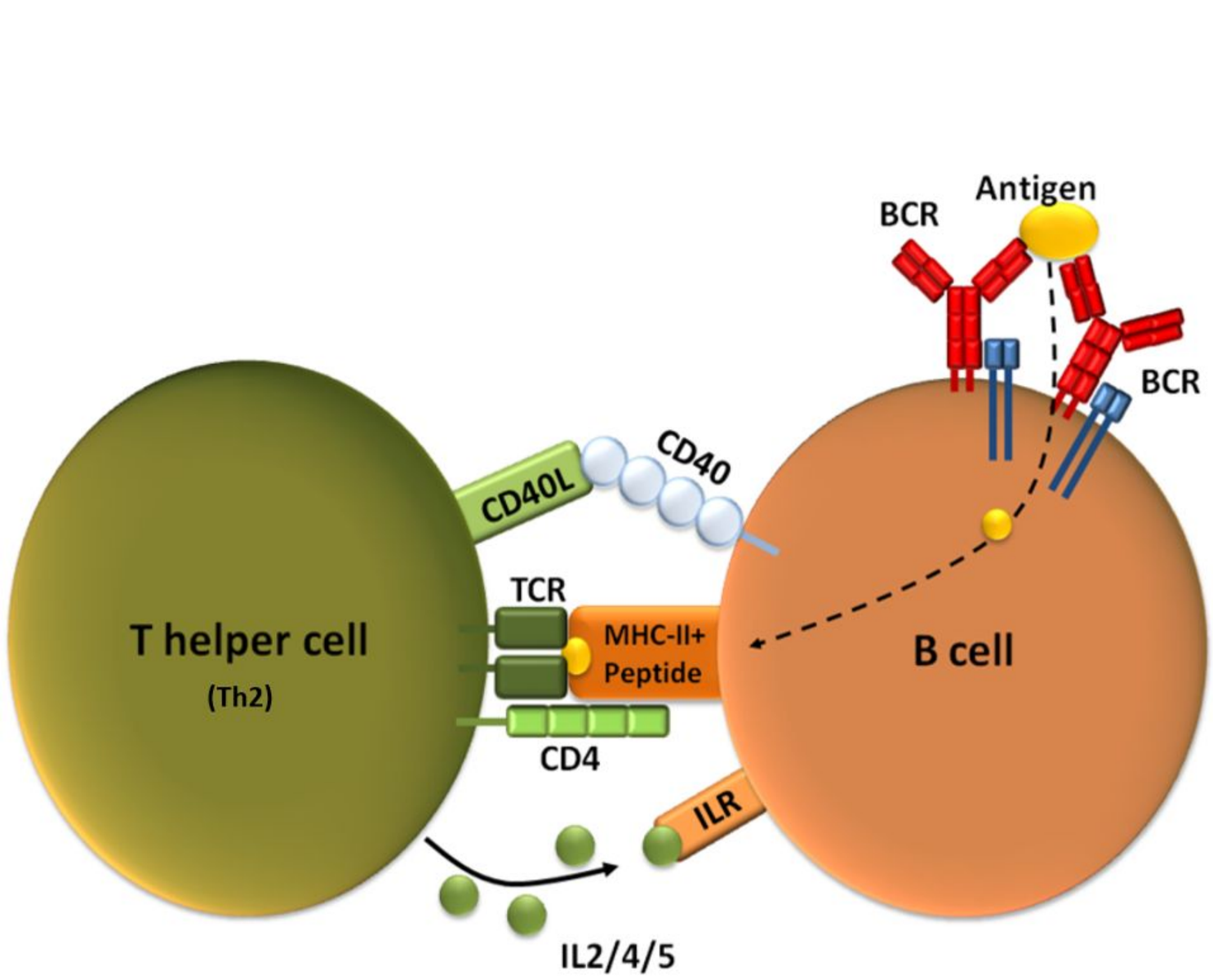
T-dependent antigen is better than T-Independent because it has memory cells which means protection for a long time. One antibody which is produced by particular B-cell which is stimulating against specific antigen will be specific for that antigen (Lock and Key) and those B-cells as long as they live will produce the same antibody. When you vaccinated against a disease you will have antibodies that will destroy the disease very fast without causing any damage. If the antigen is BIG the antibody will do "Agglutination" and if the antigen is SMALL the antibody will do "Precipitation"

Activation of B cells by antigens

T- dependant	T- independent antigens
- 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. Require T-helper cells	-Antigens are mainly polysaccharides or lipopolysaccharides with repeating subunits (bacterial capsules). -Immune responses induce the production of IgM of low affinity for the antigen and no immunologic memory Do not require T-helper cells

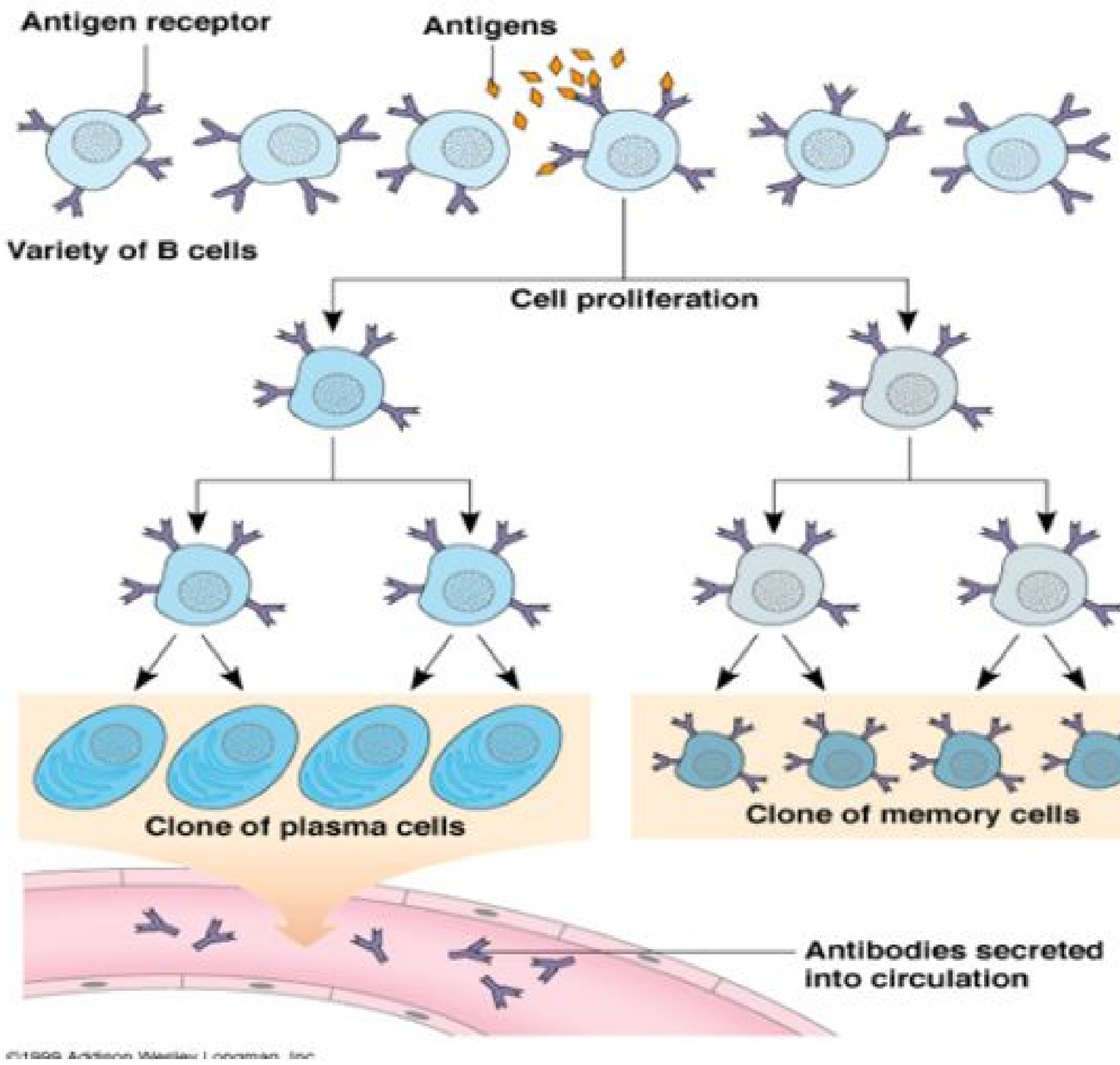
- Immunoglobulin = Antibody

B cells activation



*Th2 stimulates B cell by 2 signals:
1-Between MHC2+peptide and CD4
2-Between CD40L and CD40

Clonal selection and clonal proliferation



Clonal selection and clonal expansion

*from 435 team

- **Clone:**

A group of identical cells derived from a single cell.

- **Clonal Selection:**

A hypothesis which states that an individual lymphocyte (specifically, a B cell) expresses receptors specific to the distinct antigen, determined before the antibody ever encounters the antigen. Binding of Ag to a cell activates the cell, causing a proliferation of clone daughter cells.

- **Clonal Expansion:**

Production of daughter cells all arising originally from a single cell. In a clonal expansion of lymphocytes, all progeny share the same antigen specificity.

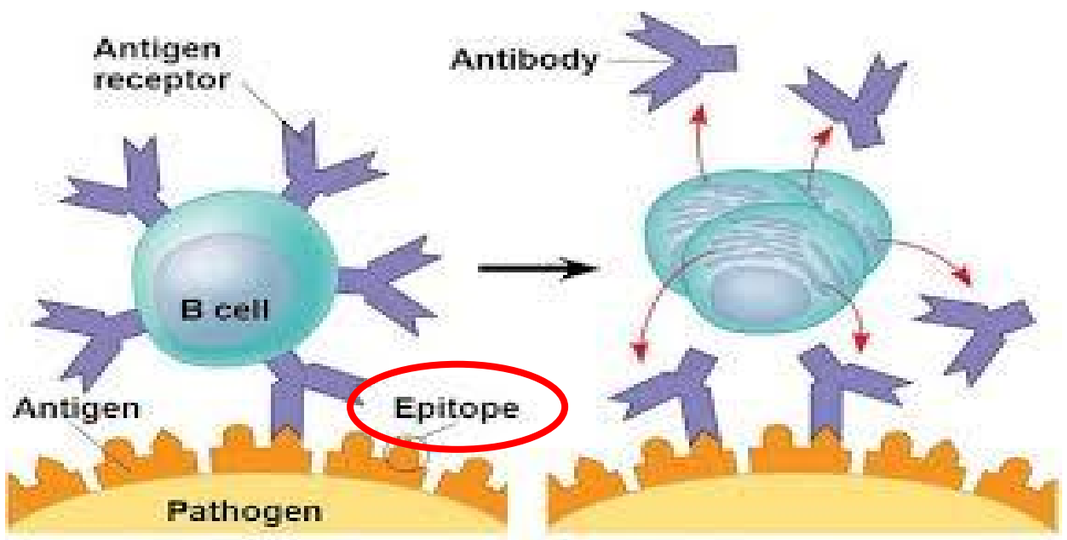
For further explanation:

Antibody (Armando's)

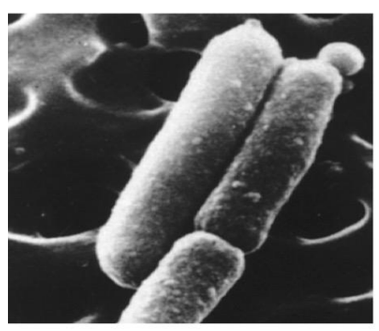
Antibodies

- Antibodies are **immunoglobulins** with specific functions.
- Function: 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

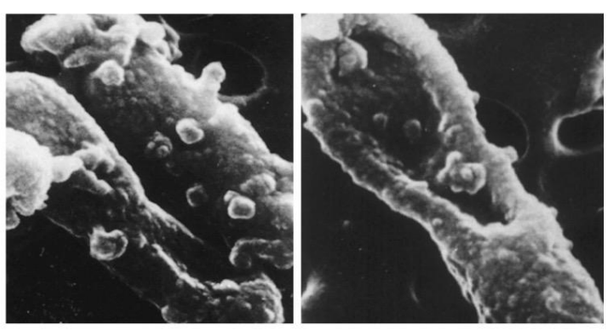
*Antibodies are found in extracellular fluids (blood plasma, lymph, mucus, etc.) and on the surface of B cells.



Electron micrographs of the effect of antibodies and complement upon bacteria.



Healthy E. coli

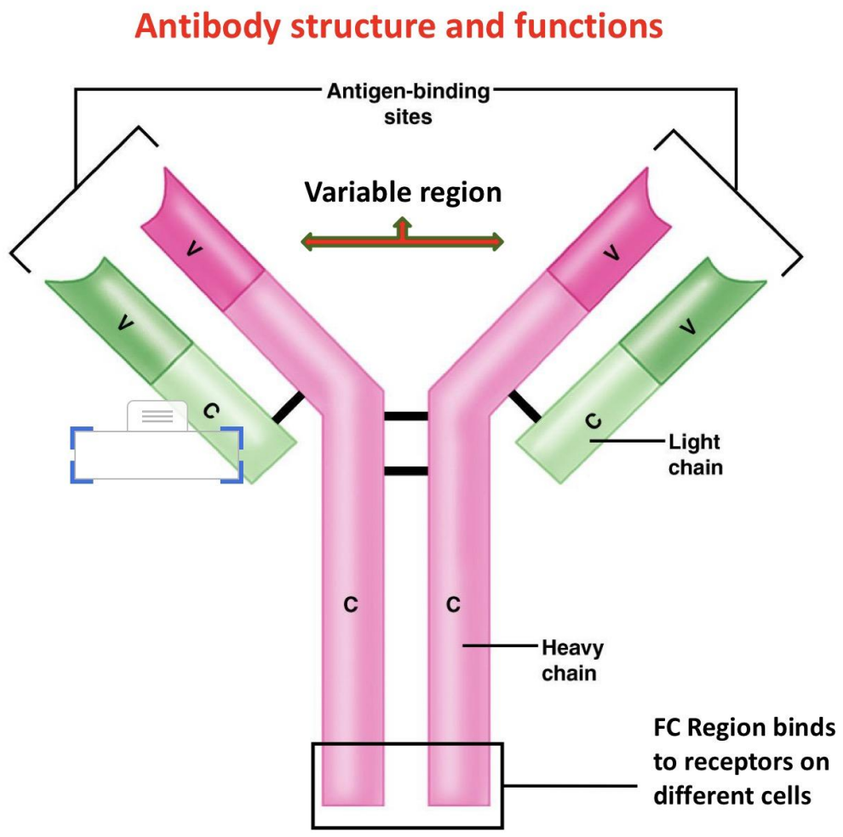


Antibody + complement-mediated damage to E. coli

Antibody structure:

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**"
4. Variable region has the potential to bind with particular classes of antigens
5. 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
6. Can fit as precisely as a lock-and-key to an antigen

*variable reign is where the specificity lines



Made up of **FOUR** polypeptides (amino acid chains).

Two longer and larger **(Heavy chains)** and the other two shorter and smaller **(Light chains)**

Have the shape of a letter "Y"

*from 435 team

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.

IgG	IgM	IgA	IgD	IgE
1-Most abandon (80% of total serum antibody) 2- complement fixation. 3- placental transfer.	1- complement fixation.	Location: Secretions (tears, saliva, mucus, intestine, milk) Blood, lymph	Location: B cell surface, Blood, lymph	Location: Bound to mast and basophil cells throughout body, blood

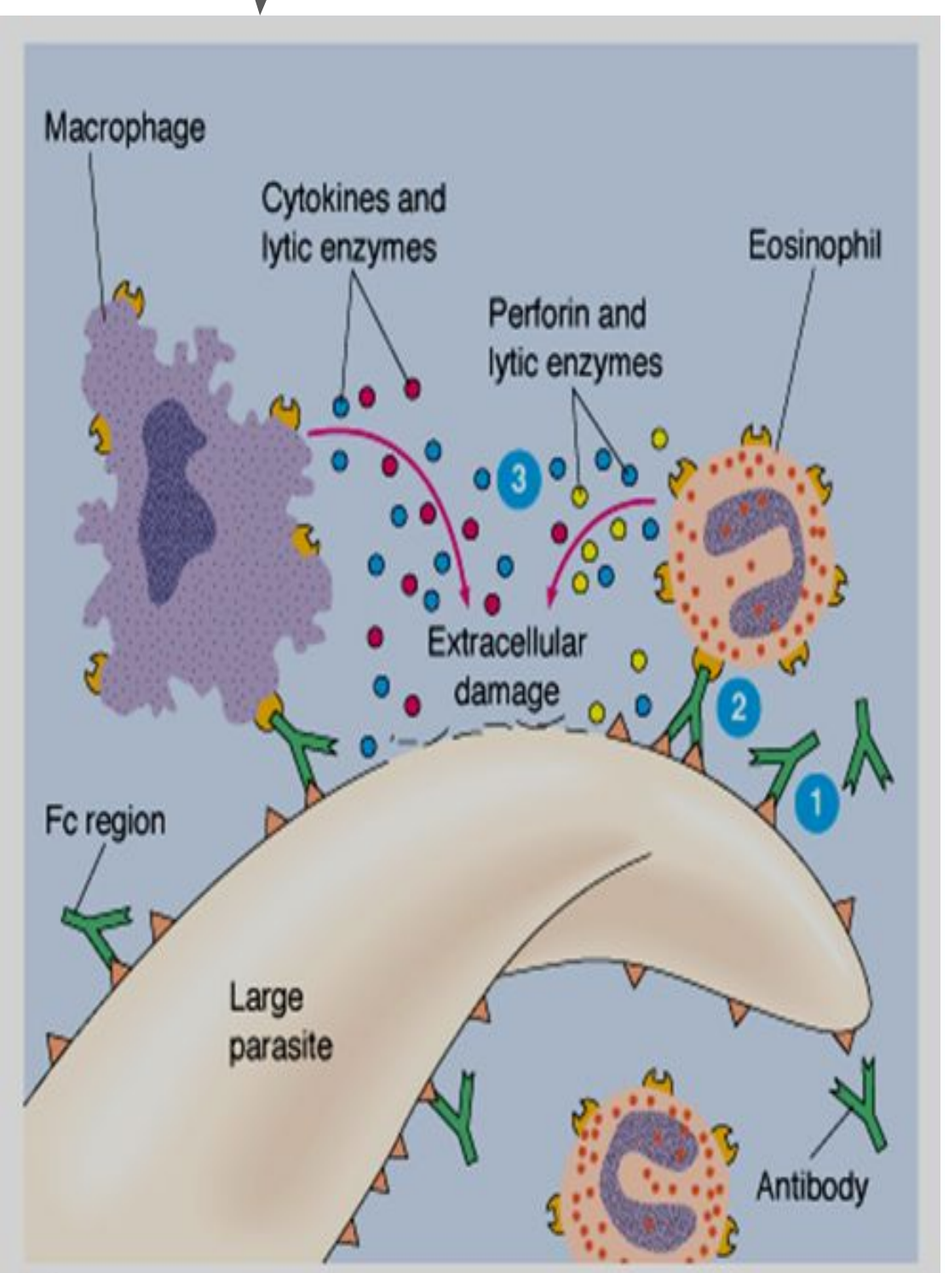
functions of antibodies:

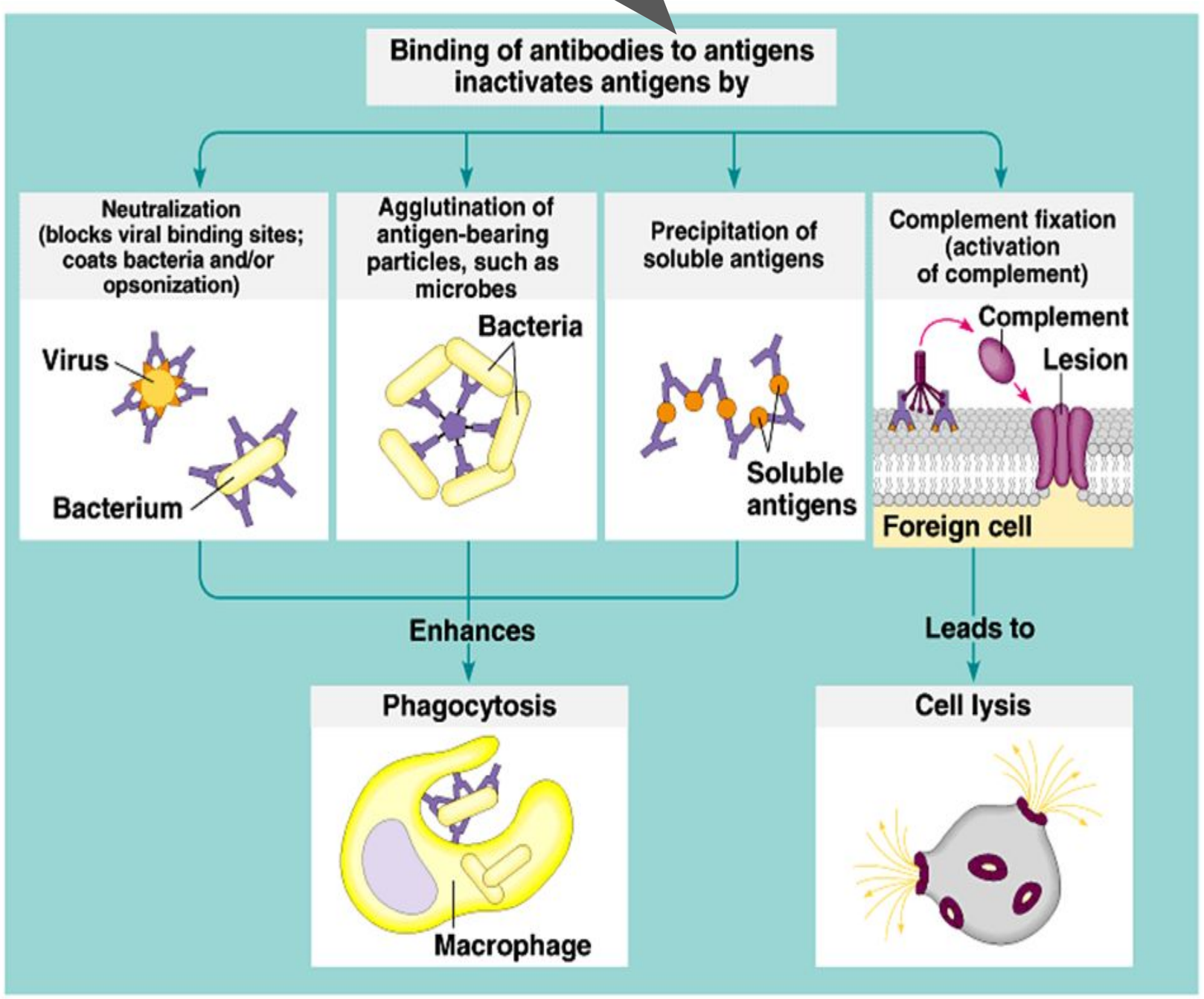
Functions of antibodies

- Transplacental transfer: IgG
- Antibody dependent cell-mediated cytotoxicity
  - 1-antibodies coat infecting cell (large parasite usually) FC facing outwards
    - Parasite e.g. big worms.
  - 2-NK (lysing ability), macrophage, neutrophils and eosinophils have receptors for FC reign of antibody
    - When all the NK, neutrophils, macrophages and eosinophils try its best to phagocyte the parasite and fail, it start to release enzymes to destroy it
  - 3- secretion of lytic enzymes to destroy parasite
- Binding of antibodies to antigens inactivates antigens by:
  - Classical pathway, after binding to antigen IgM+++,IgG1>IgG3>IgG2
    - Complement fixation (activation of complement)
      - Enhances phagocytosis
  - Precipitation of soluble antigens
  - Neutralization (blocks viral binding sites; coats bacteria and/or opsonization)
    - Antibodies coat infecting cells and facilitate their phagocytosis by cells possessing Fc Receptors.
    - Enhances phagocytosis
  - Agglutination of antigen-bearing particles, such as microbes
    - Enhances phagocytosis

Complement system (Dr. Najeeb)

Complement system Short video

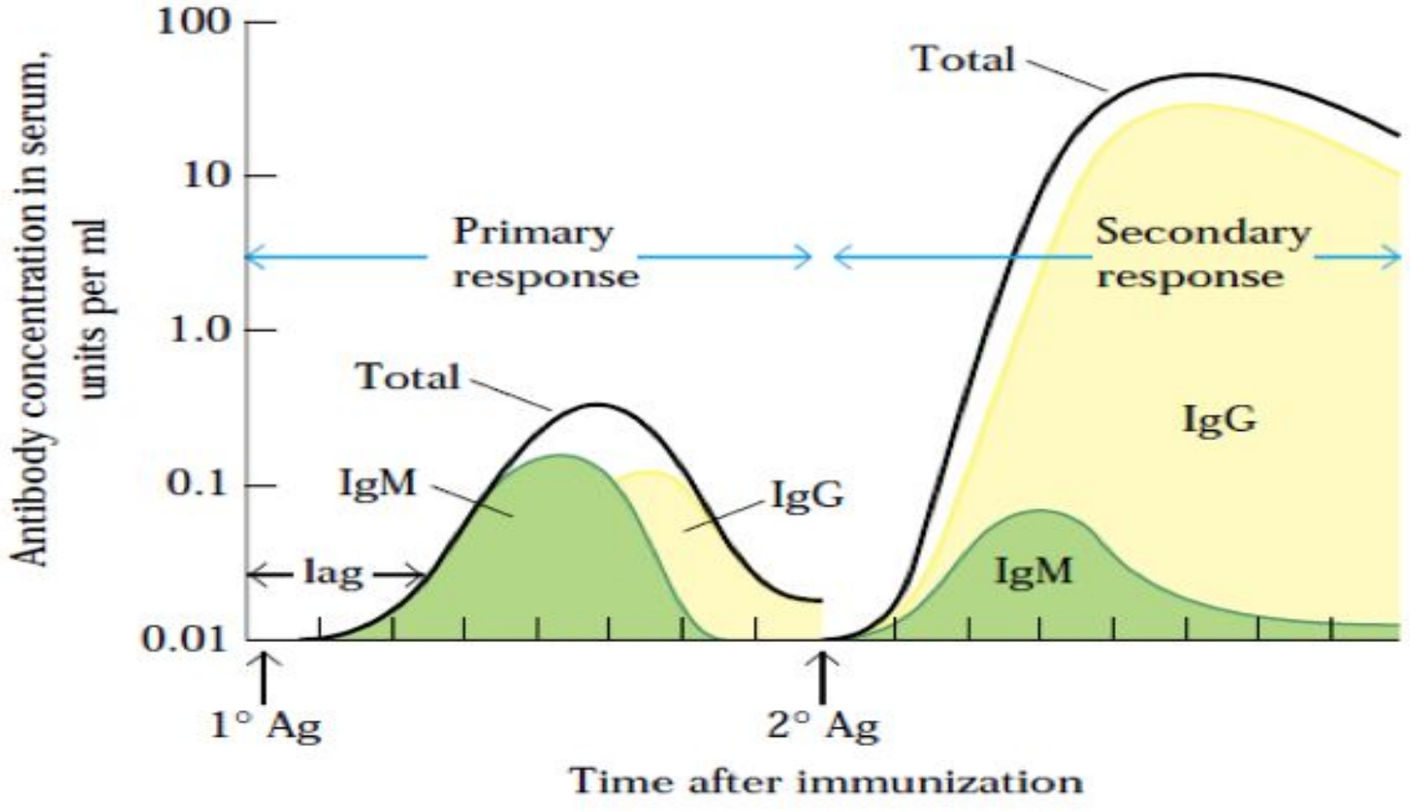




Primary & Secondary immune responses:

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

Concentration and type of antibody in primary and secondary immune responses:



The time between application of a stimulus and the reaction

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
Antigens	Thymus-dependent and thymus-independent	Thymus-dependent
Antibody affinity	Lower	Higher

--433 Notes—

The largest Immunoglobulin is IgM then IgA. The most abundant is IgG. If the IgE is high in concentration, which means it's allergic. The mother milk will produce after 48 hours, before that the mother will feed the child with glostern which rich with IgA to protect him.

Concentration & type of antibody in primary & secondary immune responses:

Example: hepatitis vaccination.

Primary immune responses:

First injection: IgG and IgM is produced because the body and the B cell and the antigen presenting cell look to the antigen, they activate and stimulated T cell relies cytokines help the B cell to produces antipodes and then produce some plasma cell and some memory cell. Small amount of plasma cell produces small of antibody. And there is a development of some memory call

So on this stage there is a caring of memory cell.

The IgM is predominant antibody in the primary immune responses.

Secondary immune responses:

Second injection: IgG is going sky high because of the memory cell is reacted to the antigen very quickly so they produce small amount of IgM and a lot of IgG. The IgG is predominant antibody in the primary immune responses.

Through the antibody we can determination the type of the inflammation. (-) = There isn't & (+) = There is

-IgG	-IgM	No infection
+IgG	-IgM	Infection in the past
+IgG	+IgM	Acute infection

MCQs:

1- B cell can be activated by antigen to produce antibodies only by the antigen itself:

A. True
B. F

2- Secondary humoral immune response is mediated by?

A. IgG
B. IgA
C. IgE
D. IgM

3- What is the most common immunoglobulin in serum?

A. IgA
B. IgA
C. IgD
D. IgG

4- The immunoglobulin bound to mast cell and basophil cells is:

A. IgE
B. IgM
C. IgD
D. IgG

5- Antibody structure is made of … polypeptide chains:

A. 2
B. 4
C.6
D.8

6- Immunoglobulin has complement fixation ability:

A. IgG
B. IgM
C.IgD.
D. Both A and B

7- The immunoglobulin helps in placental transfer is:

A. IgA
B. IgG
C. IgD
D. IgE

8- Antibodies bind to specific sites on antigen surface are called:

A. Epitopes
B. Peritopes
C. Light chain
D. Heavy chain

Answers:

1. B
2. A
3. D
4. C
5. B
6. D
7. B
8. A

MEDICINE
KING SAUD UNIVERSITY

Contact us

Email: Immunology436@gmail.com

Twitter: Immunology436

IMMUNOLOGY

436's TEAMWORK

Team Leaders

Ghaida Alsaeed

Basel almeflh

Team members

Aroob Alhuthail

Aldorah Alhamdi

Ghada Alskait

Hanin Bashaikh

Lara Alsaleem

Rawan Alwadee

Abdullah alharbi

Abdulmajeed almutairi

Abdulmajeed alammar

Basel alanazi

Moayed Ahmed

Mohammed alhammad