MED441
KING SAUD UNIVERSITY

Antibody-mediated immunity

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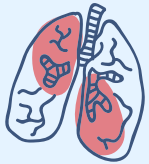
Colour index:
Main text
IMPORTANT
Drs notes
Females slides
Male slides
Extra

Foundation block — Editing file

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

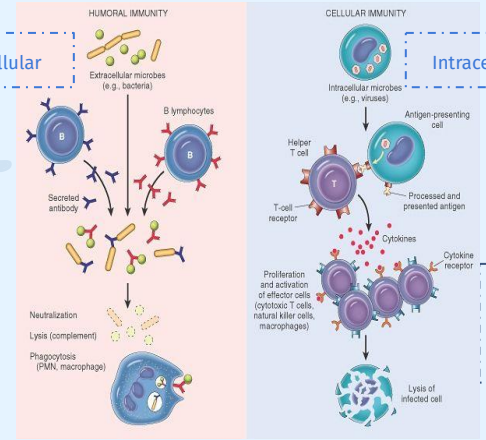
Quick introduction

Helpful video

- Types of Immunity
  - Innate (Natural) Immunity
  - Adaptive (Acquired) Immunity
    - Humoral immunity (AbMI)
    - Cell Mediated Immunity (CMI)

This lecture now

The Humoral Immune Response is the aspect of immunity that is mediated by secreted antibodies.
The response takes place in body fluids/humor such as blood and lymph



Go back to L1 slide 6 to refresh your memory on Antigens

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

Activation of B cells by antigens

T-dependent antigens

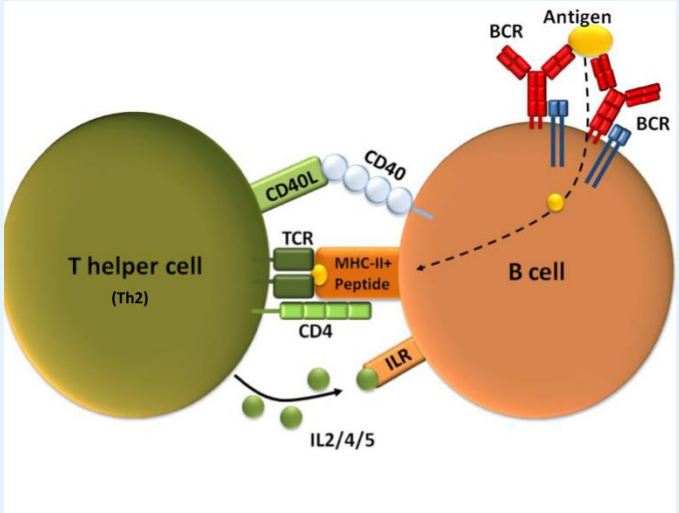
- Antibody production by B-cells requires **T**-helper cells
- Antigen presenting cells (APC) recognizes the Antigen & presents it to T-helper cells
- T-helper cells stimulate **B**-cells specific for that Antigen to become plasma cells
- T-dependant Antigens are mainly proteins on viruses, bacteria & other foreign materials

T-independent antigens

- B-cells DO NOT require T-helper cells to produce antibody
- 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

More details later

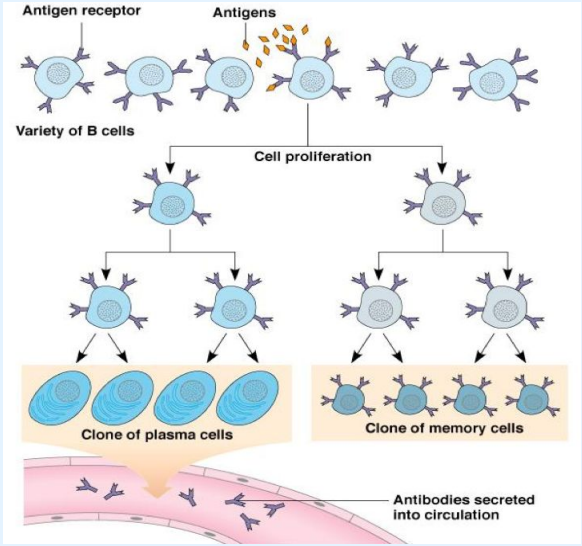
Activation of B cells (T-dependent)



T helper
Cluster of differentiation 4

- **Th1** is a **CD4** cell which promotes **Cell Mediated Immunity** (previous lecture)
- **Th2** is a **CD4** cell which promotes **Antibody mediated immunity** (this lecture)
- Cell activation leads to:
  - proliferation تكاثر / انتشار
  - Release of cytokines (lecture 2)

Clonal selection and clonal proliferation

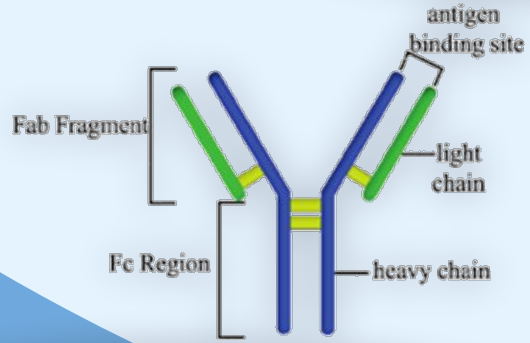


Team 439:

B-cells are **activated** by the binding of an Antigen to a **specific receptor** on its surface, which **stimulates** the cell to divide and proliferate (multiply very fast) In the end it produces plasma cells and memory cells

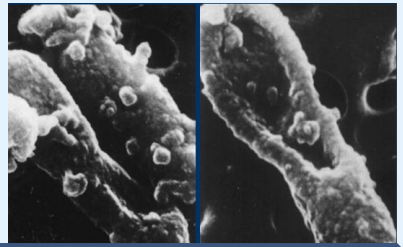
Antibodies

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



- Made up of four polypeptides chains
- Two longer and larger (heavy chains) and the other two shorter and smaller (light chains)
- Have the shape of a letter **"Y"**

Healthy E. coli

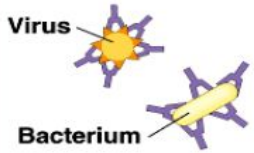


Antibody + complement-mediated damage to E. coli

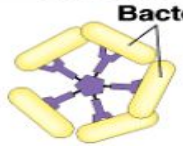
Protective functions of antibodies

Binding of antibodies to antigens inactivate antigen by

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

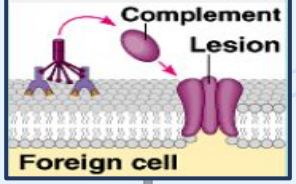


Agglutination of antigen-bearing particles, such as microbes



Precipitation of soluble antigens

Complement fixation (activation of complement)

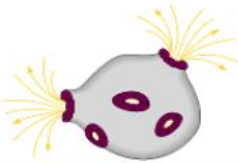


Enhances

Phagocytosis

Leads to

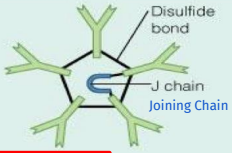
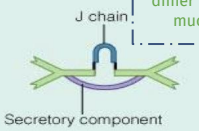
Cell lysis



Immunoglobulin Classes

Med436: Remember: GAMED

Found as monomeric in serum, then becomes a dimer "IgA" in mucous

Characteristics	IgG	IgM	IgA	IgD	IgE
					
Structure (Highest)	Monomer	Pentamer	Dimer (with secretory component)	Monomer	Monomer
Percentage of total serum antibody	80%	5–10%	10–15%*	0.2%	0.002% (Lowest)
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 (Least)
Complement fixation (Covering Fetus)	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

Alternative pathway

*Percentage in serum only; if mucous membranes and body secretions are included, percentage is much higher.
† May be yes via alternate pathway.

Activated complement by Classical pathway

Functions of antibodies

439Note: Its a link that transfer maternal autoantibodies from the pregnant mother to the fetus through the IgG placenta

classical pathway, after binding to antigen IgM, IgG1 > IgG3 > IgG2

IgG

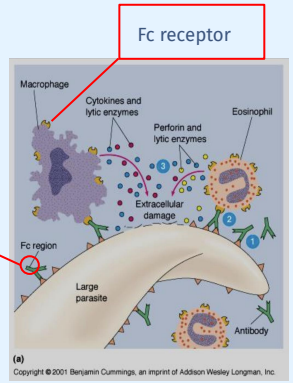
EXTRA EXPLANATION: **Fc receptor** is an **antibody** receptor involved in antigen recognition which is located at the **membrane** of certain immune cells (as mentioned below). Such receptors **recognize Fc fragment of antibodies**. Fc receptors binding to antibodies that are attached to infected cells or invading pathogens **contributes** to the protective functions of the immune system.Their activity **stimulates** phagocytic or cytotoxic cells **to destroy microbes**, or infected cells by antibody-mediated phagocytosis or antibody-dependent cell-mediated cytotoxicity.

Ab dependent cell- mediated cytotoxicity | **Complement activation** | **Transplacental transfer** | **Opsonization and phagocytosis**

Antibodies coat infecting cell (large parasite usually) - FC region is facing outwards

NK (lysing ability), Macrophage, neutrophils, and eosinophils have receptors for FC region of antibody

Secretion of lytic enzymes to destroy parasite



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

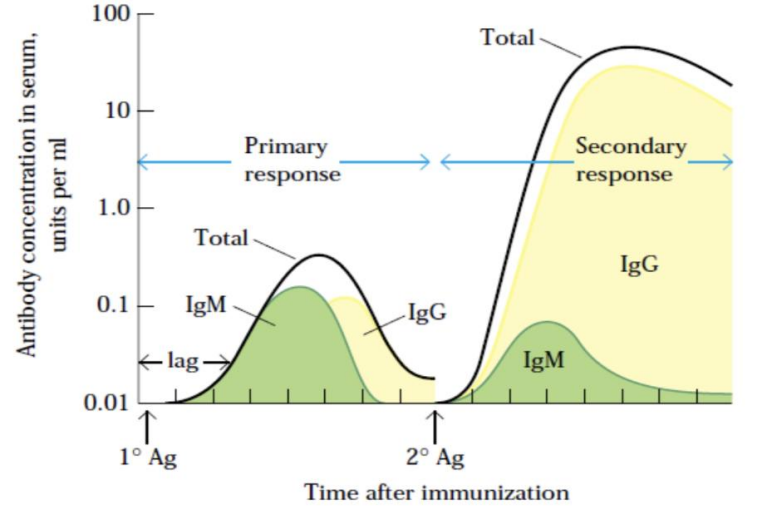
Primary & Secondary immune responses

Primary immune response: produced by initial encounter with antigen

The main antibody involved is **IgM**

Secondary immune response: produced by subsequent challenge with same antigen

The main antibody involved is **IgG**



438 Note:
This graph is an example of why we receive multiple vaccinations against diseases (Hepatitis B). It shows the efficacy differences between the initial and the second vaccinations, with the latter being much more effective.

A detailed comparison is shown in the next slide →

Comparison between Primary & Secondary responses

	Primary response	Secondary response
Responding B cell	Naive B cell (virgin) (no memory)	Memory B cell
Lag period following antigen administration	4-7 days	1-3 days
Time of peak response	7-10 days	3-5 days
Magnitude of peak antibody response	Varies depending on antigen	100-1000 times higher than primary
Predominant isotype produced	IgM	IgG

Secondary response is faster

GREAT summary video to wrap your head around the last 4 lectures (contains extra info)

Click here

Take Home Messages

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

MCQs

Q1: Which type of Antigen has no immunological memory?			
A- T-dependent Antigen	B- T-independent Antigen	C- Both	D- Neither
Q2: Antigens are mainly polysaccharides or …… with repeating subunits (bacterial capsules).			
A- Peptidoglycan	B- lipopolysaccharides	C- glycoproteins	D- lipoprotein
Q3: The Humoral Immune Response is the aspect of immunity that is mediated by secreted ……			
A- APC	B- T cells	C- Antibodies	D-Macrophages
Q4: T-helper cells stimulate B-cells specific for that Antigen to become ……			
A- Macrophages	B- plasma cells	C- Giant cell	D- Langhans cells

Q1-B, Q2-B, Q3-C, Q4-B

MCQs

Q5: Antibody structure is made of … polypeptide chains:			
A- 1	B- 2	C- 3	D- 4
Q6: Antigen bind to specific site on Antibodies surface called …			
A- Tritope	B- Epitope	C- Paratope	D- Suntop
Q7: Immunoglobulin with highest percentage of total serum antibody:			
A- igG	B- igA	C- igD	D- igE
Q8: Once an Antibody is stimulated to fit an Antigen, then it can react with?			
A- 2 Antigens at once	B- nothing	C- 1 specific Antigen	D- multiple Antigens

Q5-D, Q6-B, Q7-A, Q8-C

Special thanks and gratitude to
Immunology Team (439)

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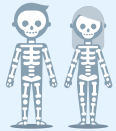

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