



Immunology

Antibody Structure and Function

Lecture 5

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Our targets

Students should understand the followings

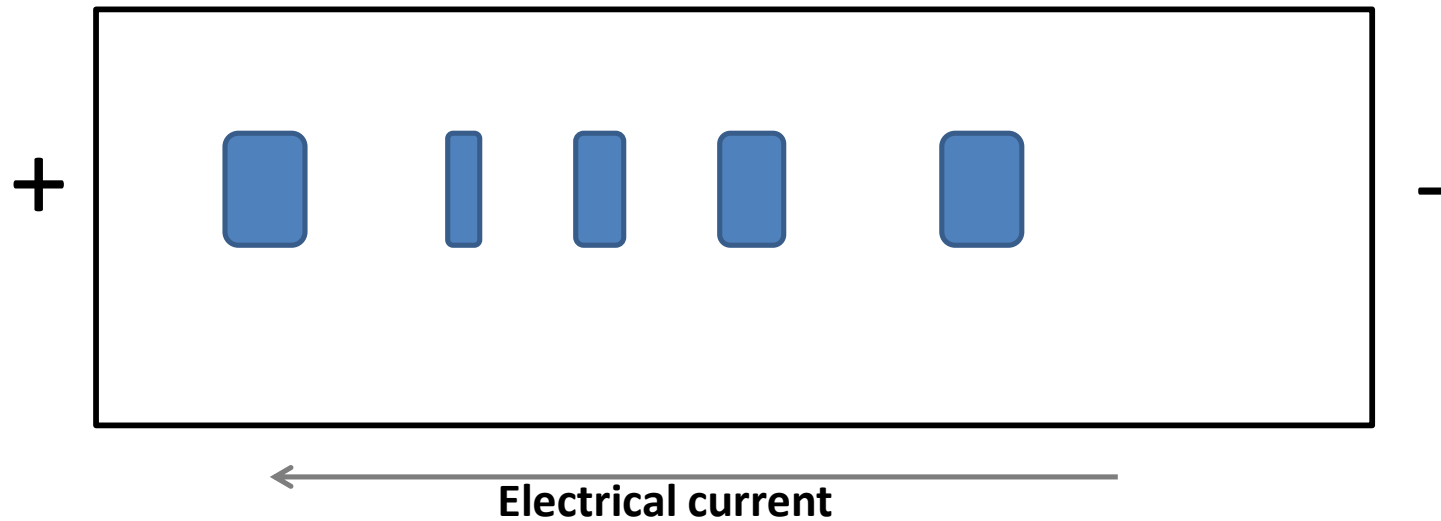
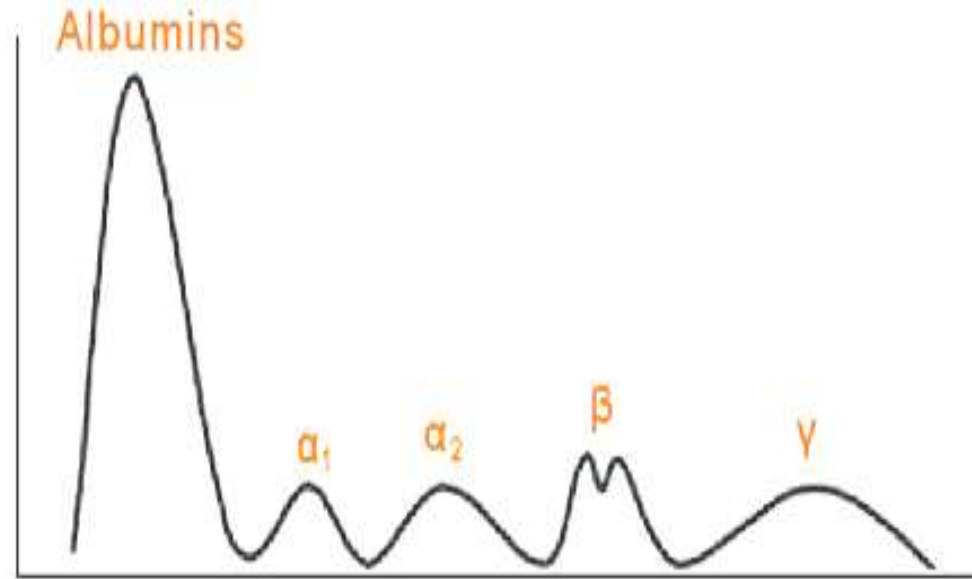
- The **meaning** of an antibody
- The **structure** of an antibody
- The **function** of each particular part
- The **different types** of antibodies
- The **mechanisms** behind the production of antibodies with **different antigen binding site**
- The mechanism of **class switching**

Introduction



Isolation and Characterization

- Normal plasma proteins electrophoresis
- Antibodies are in the gamma portion therefore they are called gammaglobulin





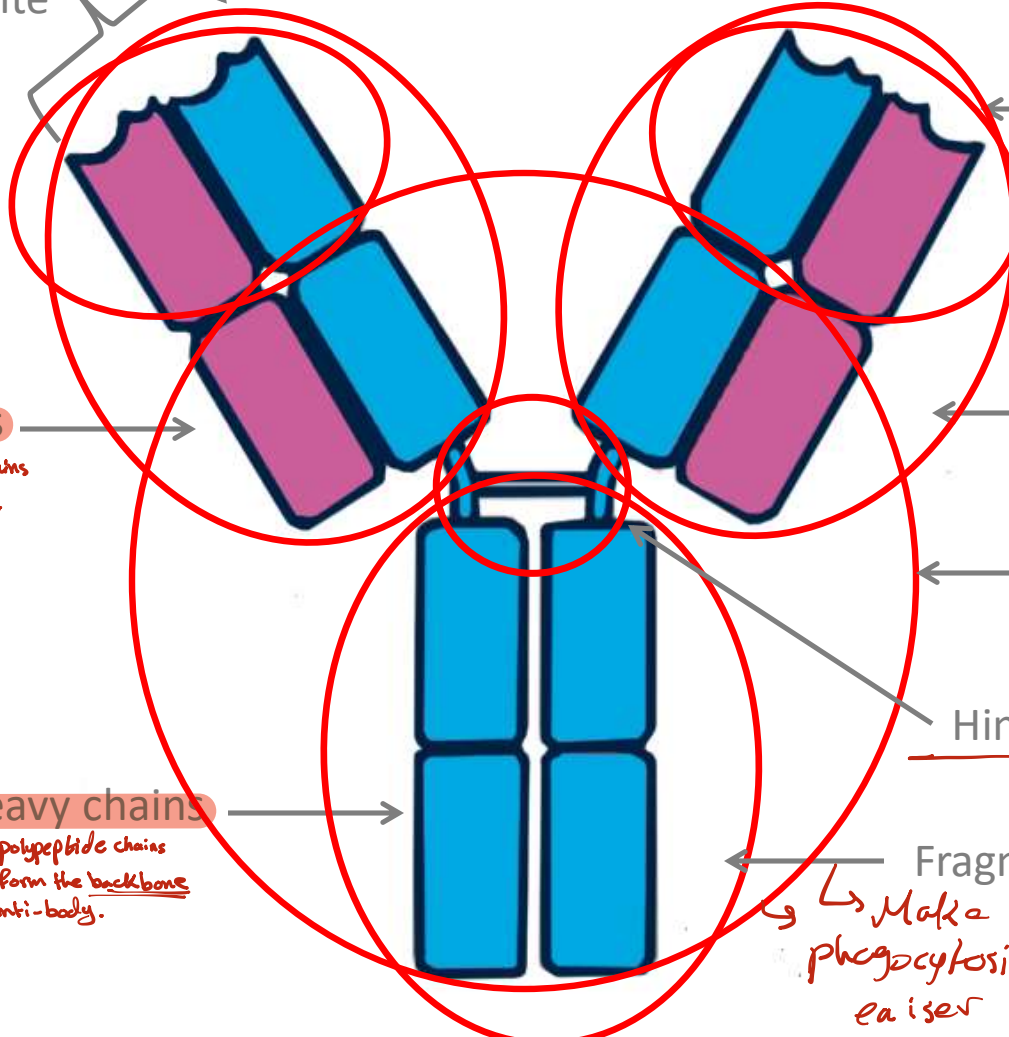
Antibody Structure

bind with
2 similar
Antigen

↳ 4 polypeptides

outer
Region bind
with Antigen

Antigen binding
site



Antigen binding Site.

Variable regions
The tips of both heavy + light chains
which is unique and bind specific
Antigen.

Fragment antigen
binding (Fab)
↳ contain the variable Region
and bind the Antigen.

Constant regions
Of light and heavy
chains

Hinge region → Flexible.

Fragment crystallizable
(Fc)
↳ Make
phagocytosis
easier

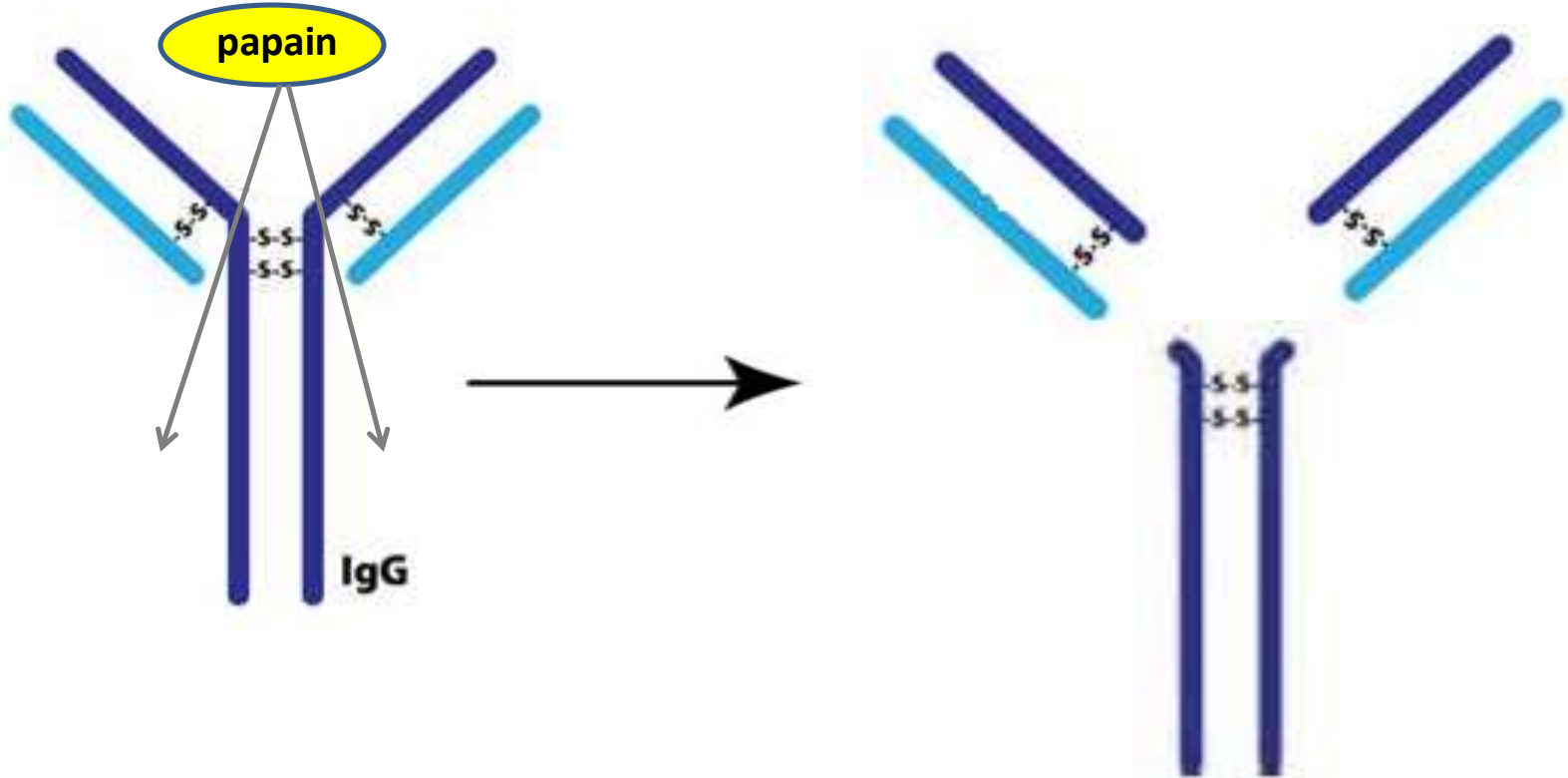
2 Light chains
↳ shorter polypeptide chains
Attached to heavy chains

2 Heavy chains
↳ Long polypeptide chains
that form the backbone
of Anti-body.

Antibody Structure



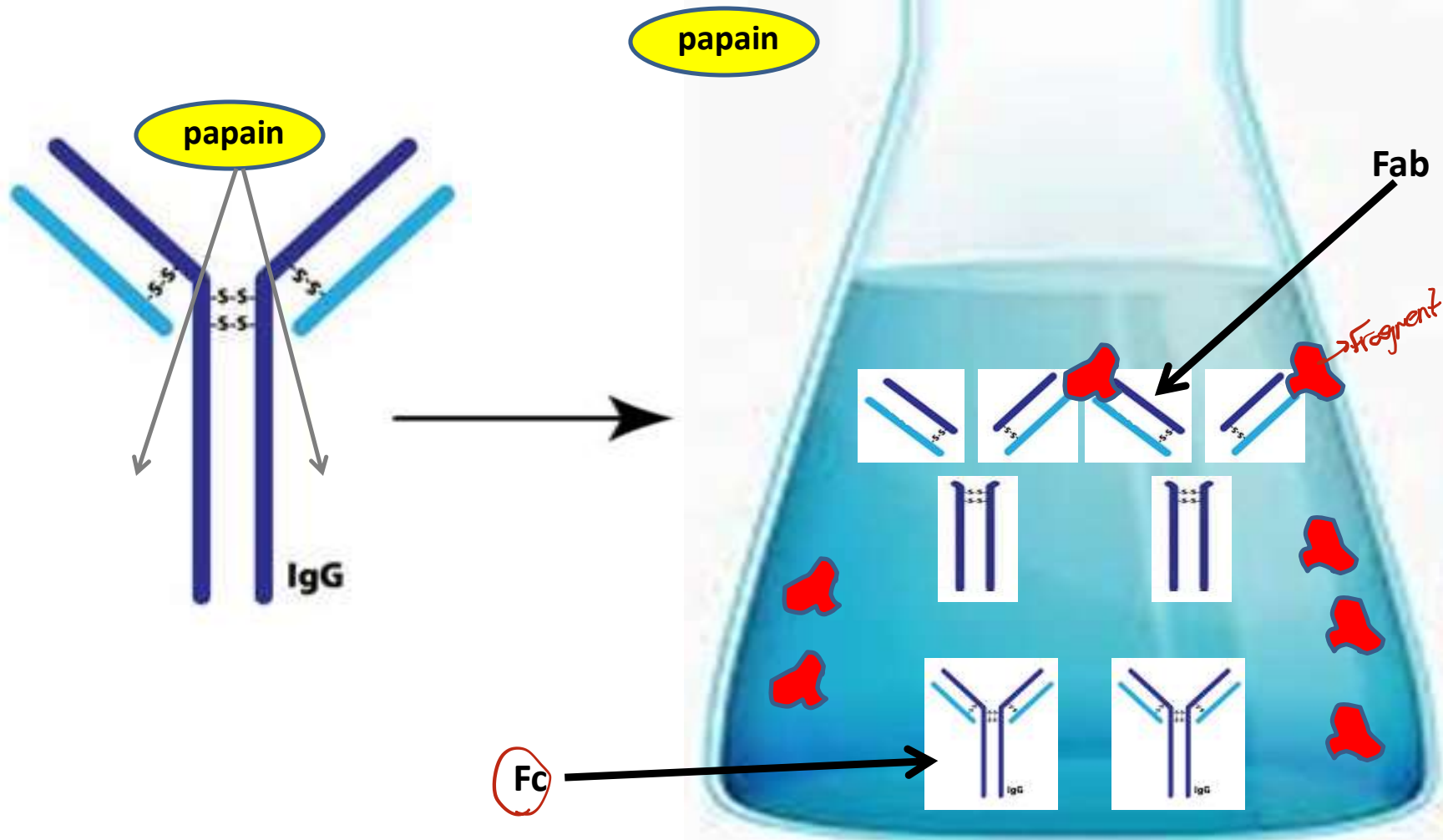
Discovery of the Fab and Fc regions



Antibody Structure



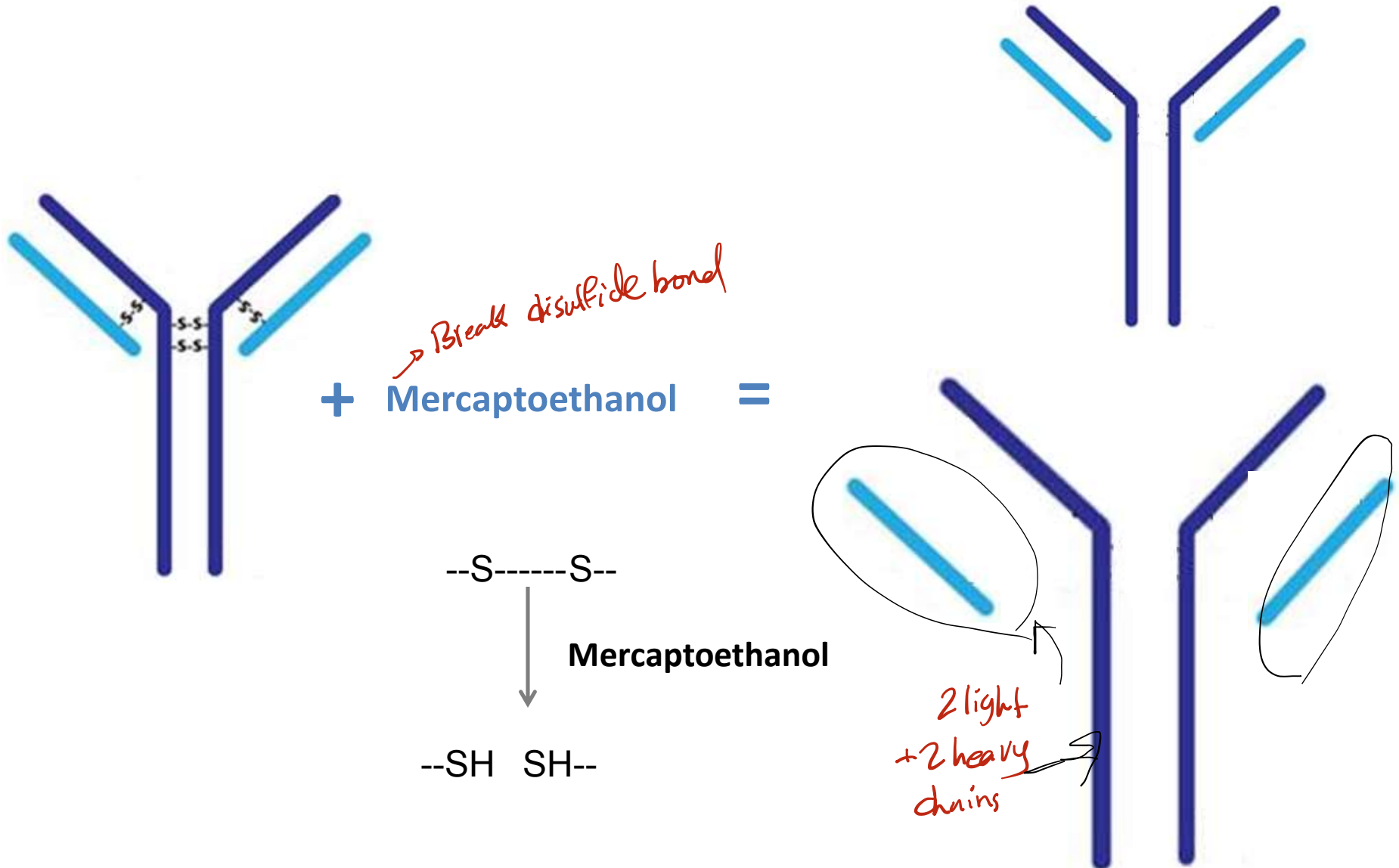
Discovery of the Fab and Fc regions



Antibody Structure



Discovery of the Ab tetrapeptide structure



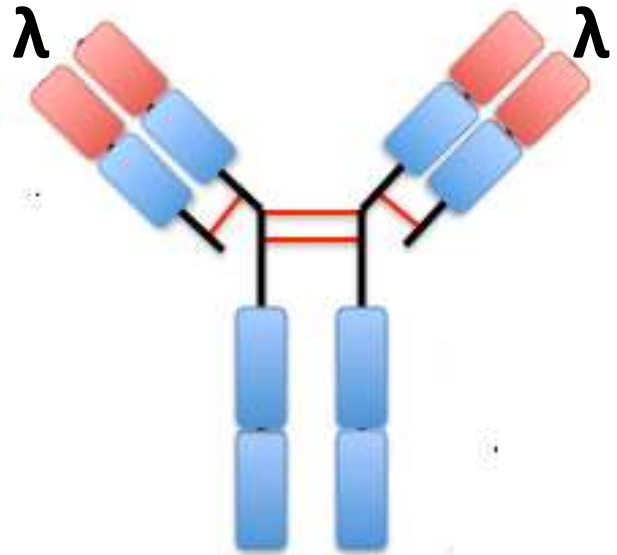
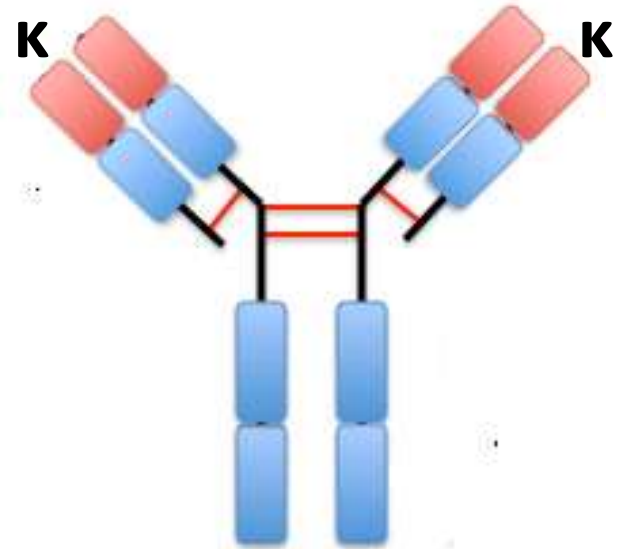
Antibody Structure



Structure of the light chain

Two classes of light chains :

- ✓ Kappa (κ) chain
- ✓ Lambda (λ) chain

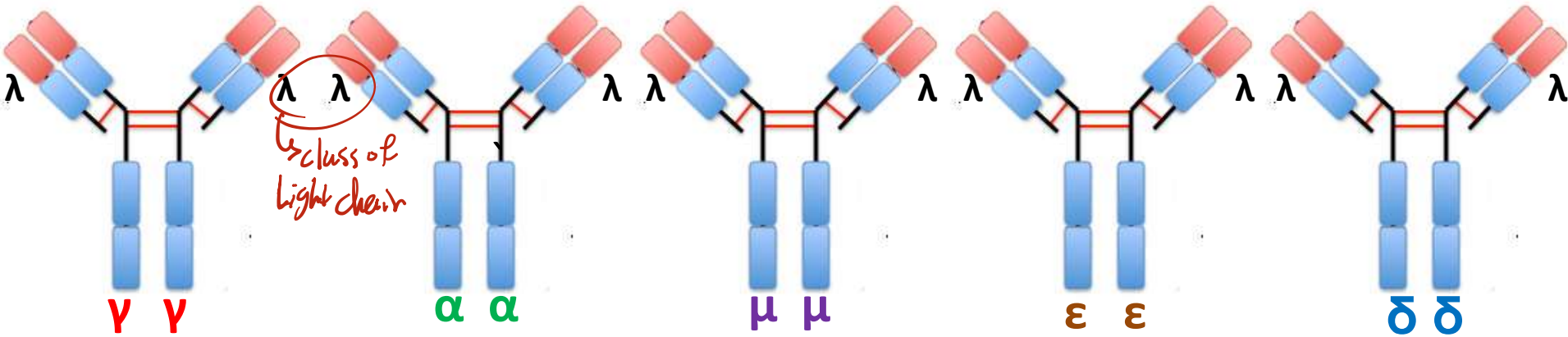
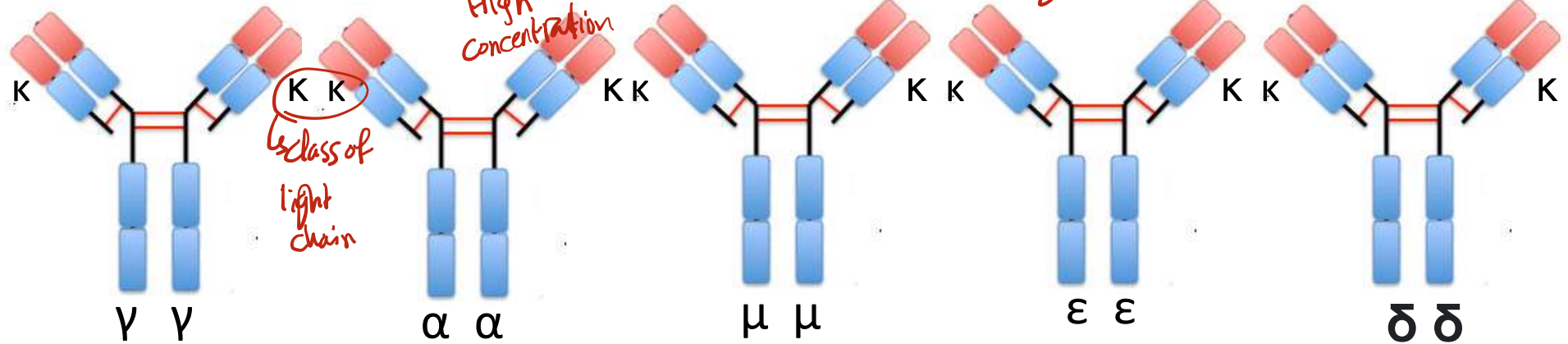


Five classes of Antibodies **Antibody Structure**



Structure of the heavy chains

From the highest to the lowest concentration



IgG
 Immunglobulin Gene
 $\gamma_2 \kappa_2$
 $\gamma_2 \lambda_2$

IgA
 $\alpha_2 \kappa_2$
 $\alpha_2 \lambda_2$

IgM
 Pentameric
 $(\mu_2 \kappa_2)_5$ bind to ten
 $(\mu_2 \lambda_2)_5$ to Antigen

IgE
 $\epsilon_2 \kappa_2$
 $\epsilon_2 \lambda_2$

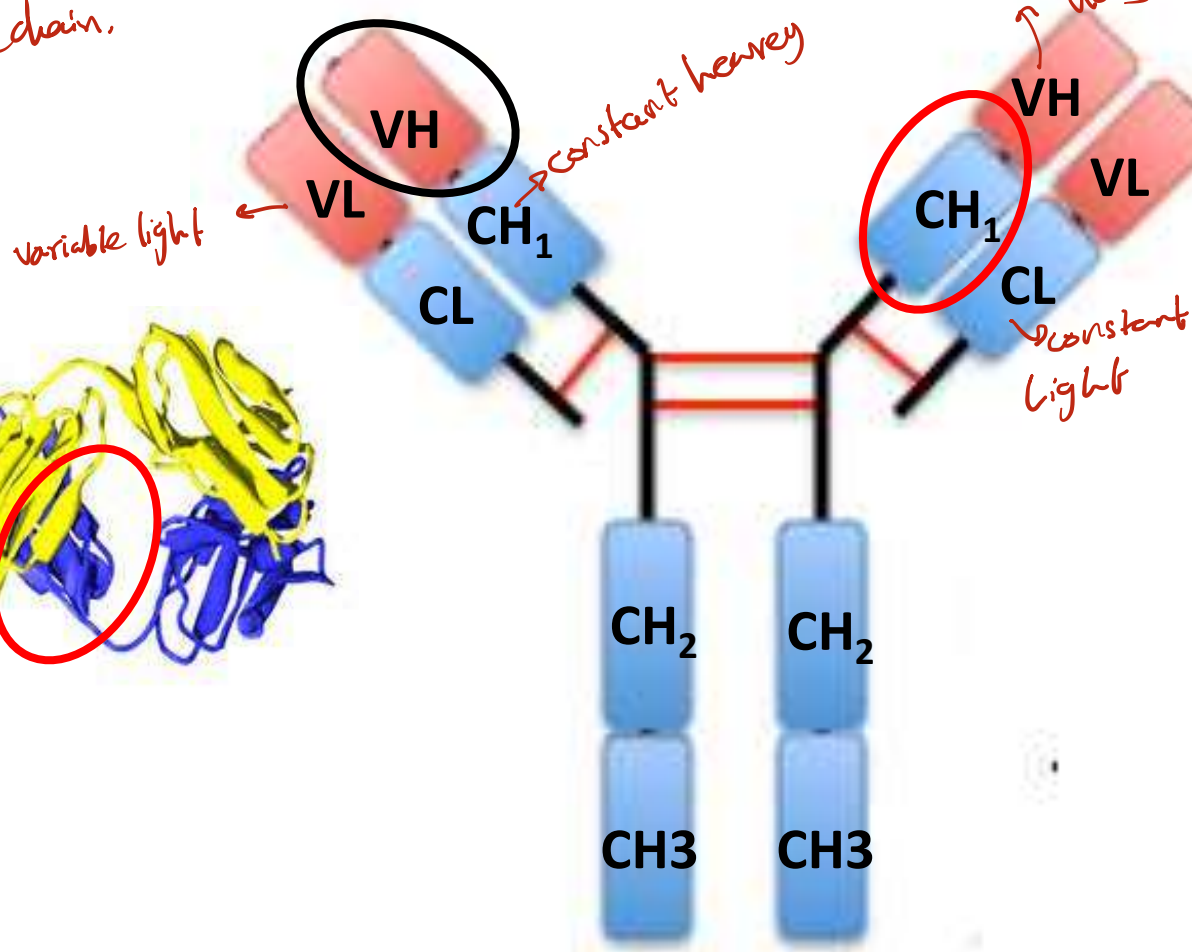
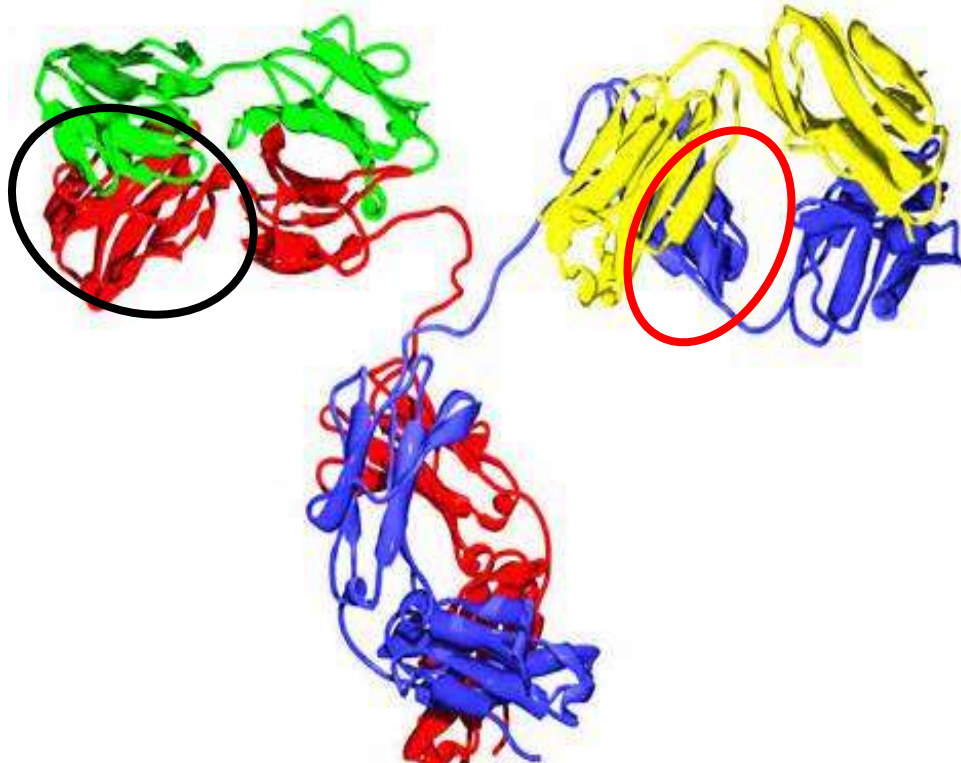
IgD
 $\delta_2 \kappa_2$
 $\delta_2 \lambda_2$

Antibody Structure



* Heavy chain domains :-
1 variable domain + 3 constant.
* Light chain domains :-
1 variable + 1 constant.

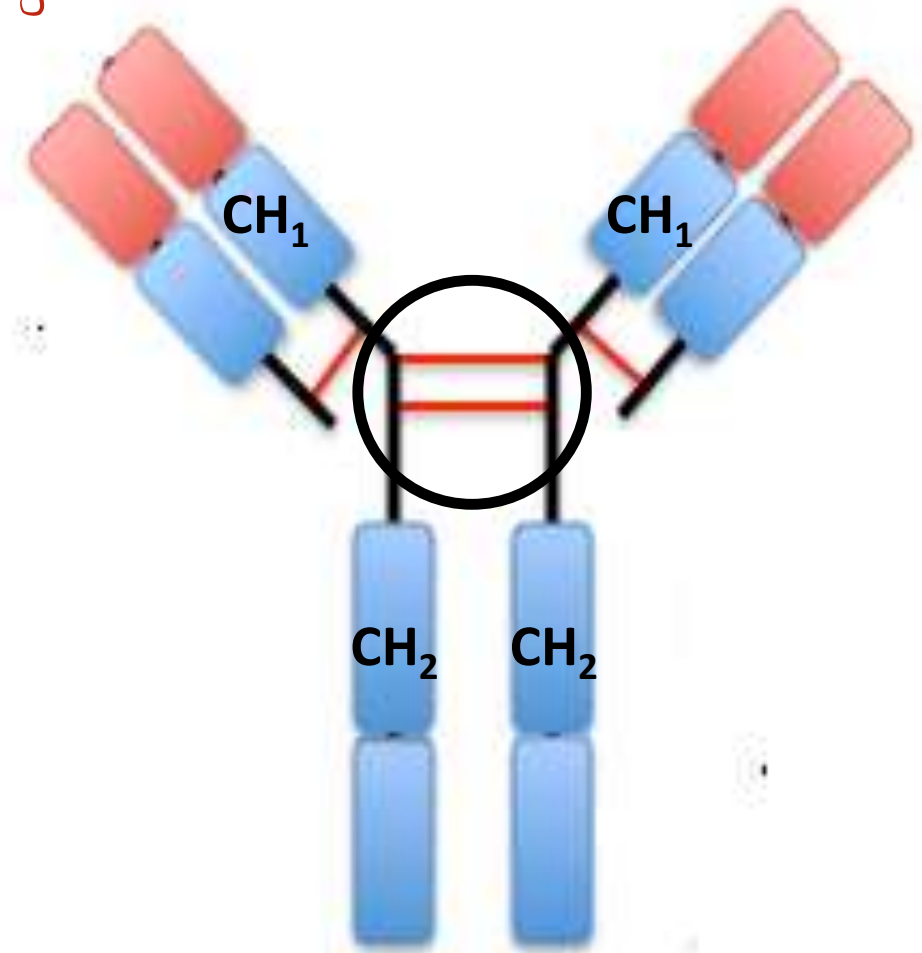
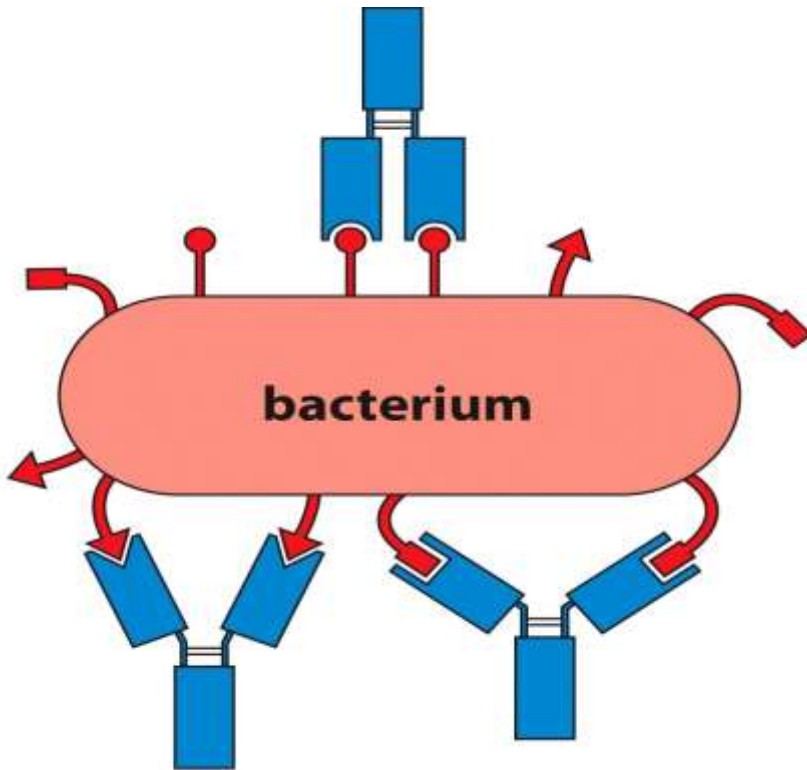
Every one have ← **Domains**
function to bind
together through
poly peptide chain.



Antibody Structure



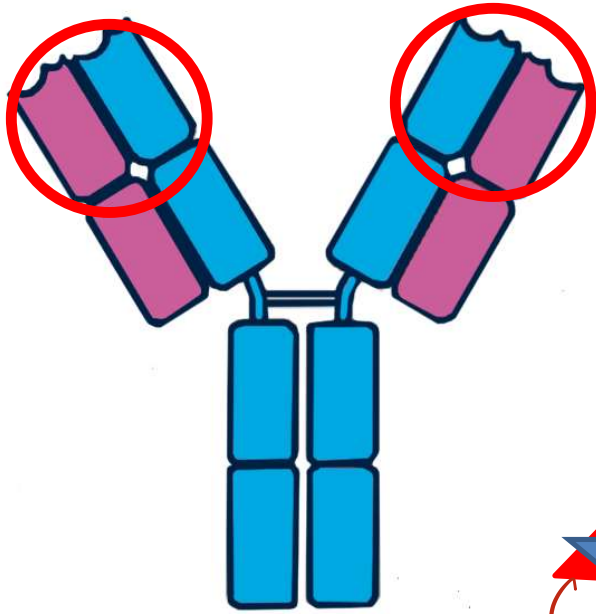
Hinge region = provide flexibility
Allowing the 2 FAB to move and bind Antigens at different angles.



Antibody Structure



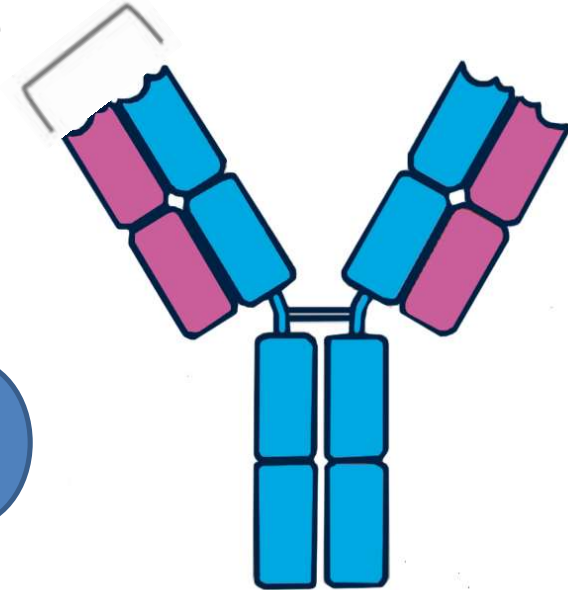
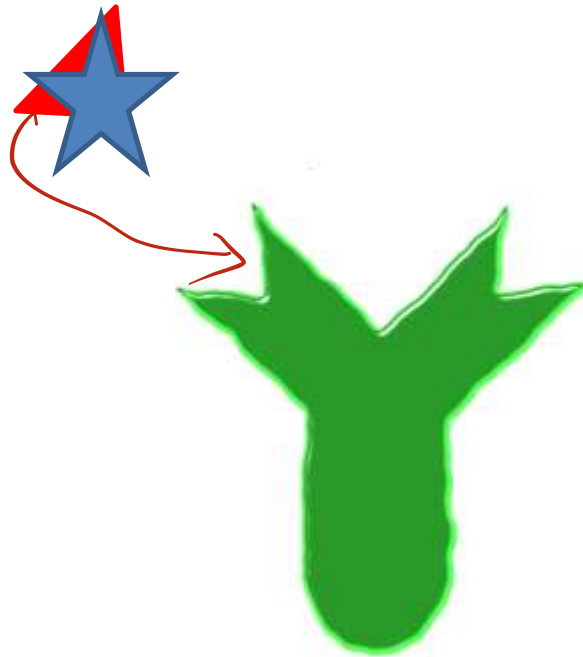
Variable region



*variable
but other
thing constant-*

← Antigen binding site

Antigen binding site



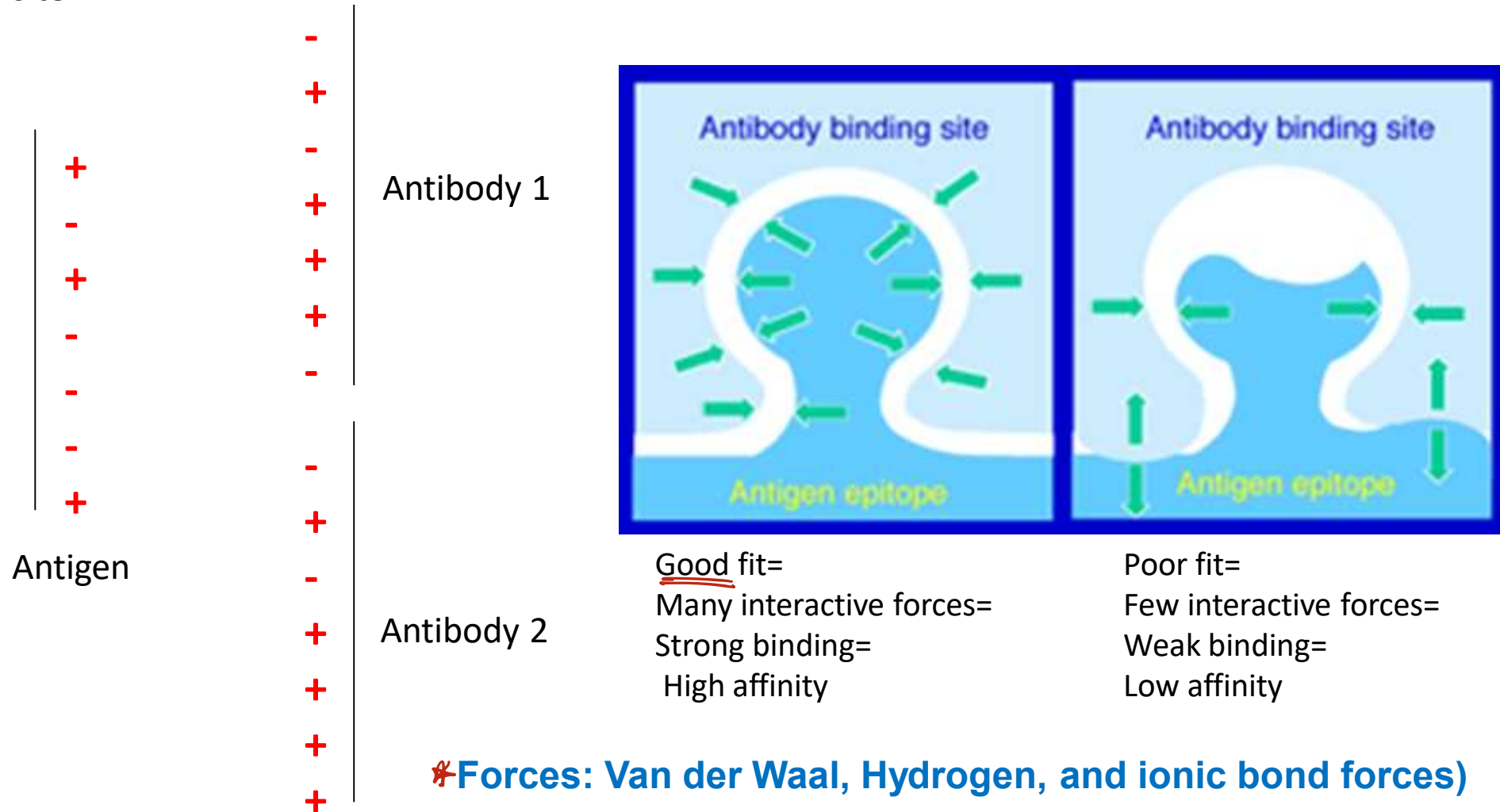
* 8 Domains in 2 heavy chain
* 4 " " " 2 light "

Antibody Structure

Antigen binding site

Affinity

measures the strength of interaction between an epitope and an antibody's antigen binding site.



Antibody Classes (isotypes)



Loop of Immunoglobulin

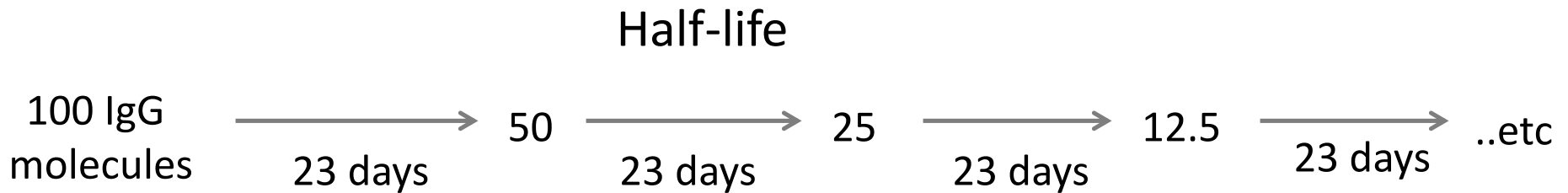
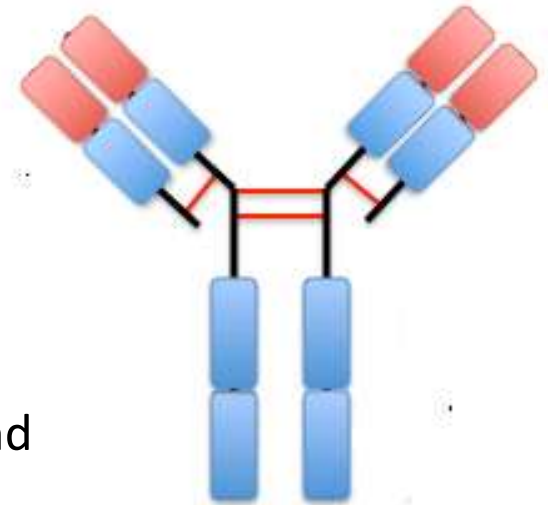
IgG = *The most Active one and*
" Larger in amount.

Monomeric antibody

Half life is about 23 days

The predominant Ab in blood, lymph fluid, CSF, and peritoneal fluid

Has four subclasses (IgG1 to IgG4)





IgG

Functions

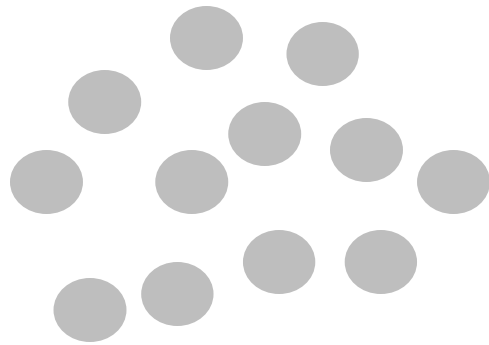
1. Precipitation reaction
2. Agglutination
3. Fetal and neonatal protection
4. Opsonization
5. Immobilization of bacteria
6. Neutralization of bacteria
7. Neutralization of toxins



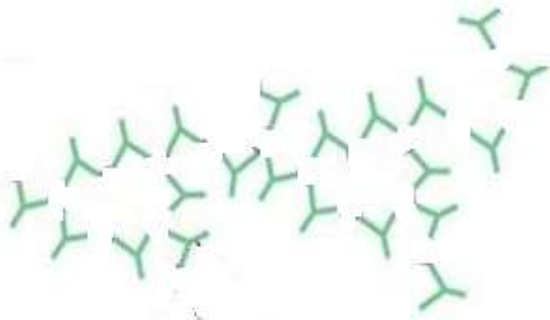
IgG

Functions

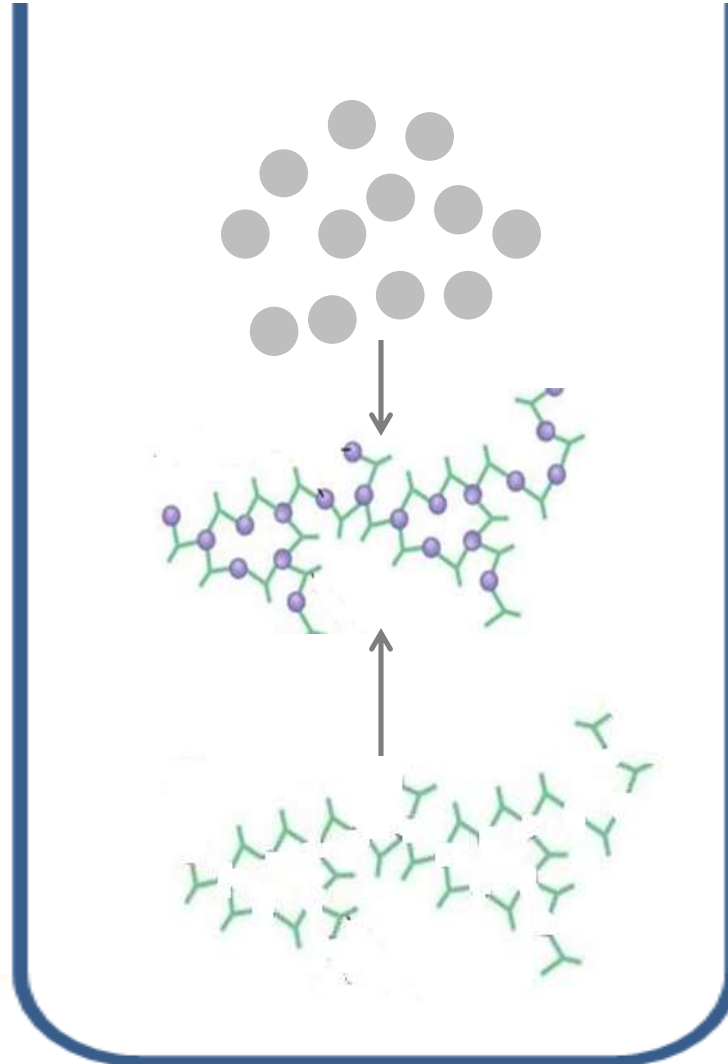
1. Precipitation reaction



Soluble antigens



Specific antibodies



Visible precipitation ring

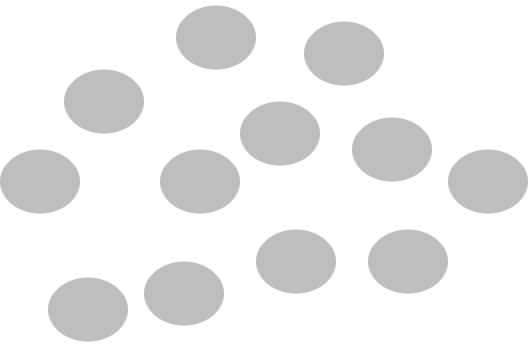
Antibody Classes (isotypes)



IgG → *opsonin* phagocytosis

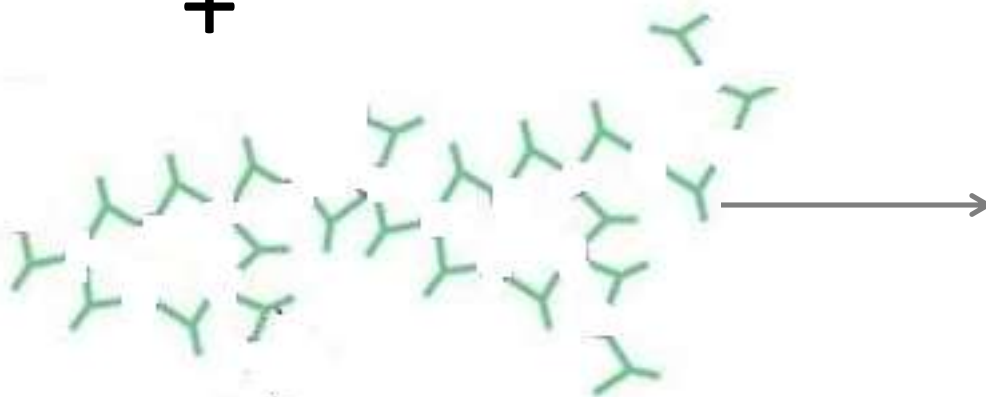
Functions

1. Precipitation reaction

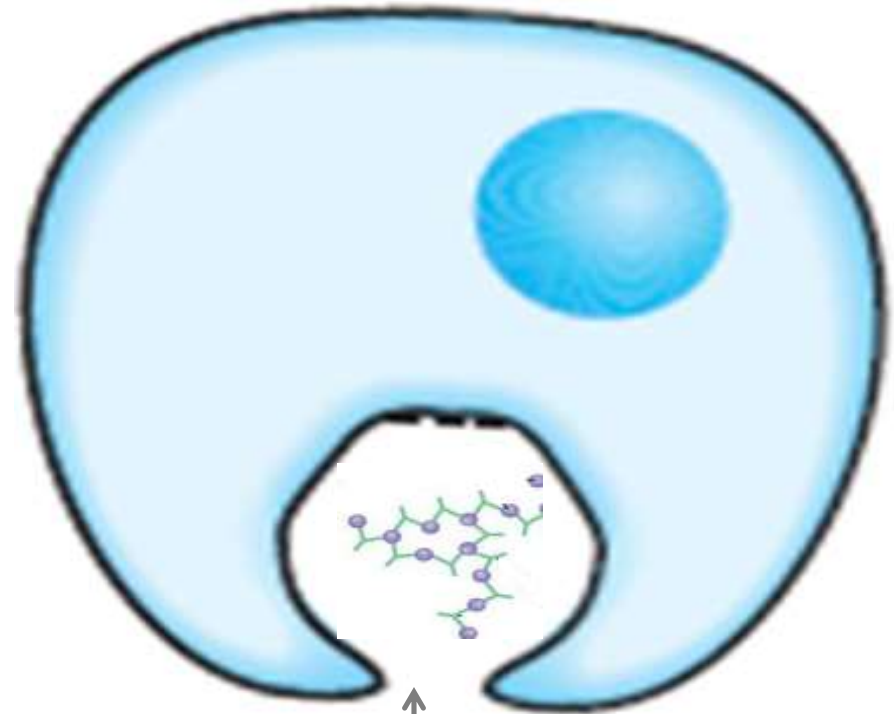


Soluble antigens

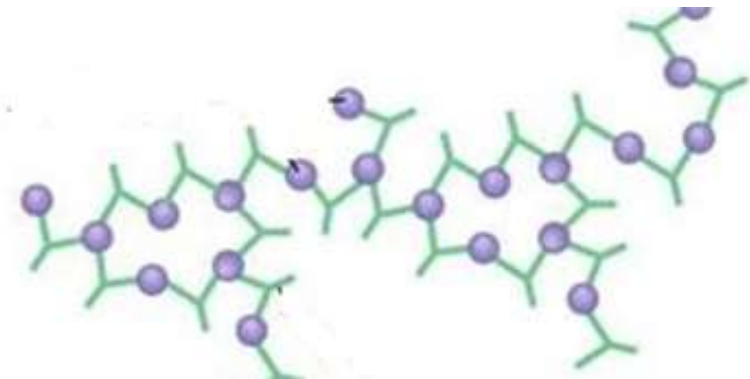
+



Specific antibodies



Facilitate phagocytosis

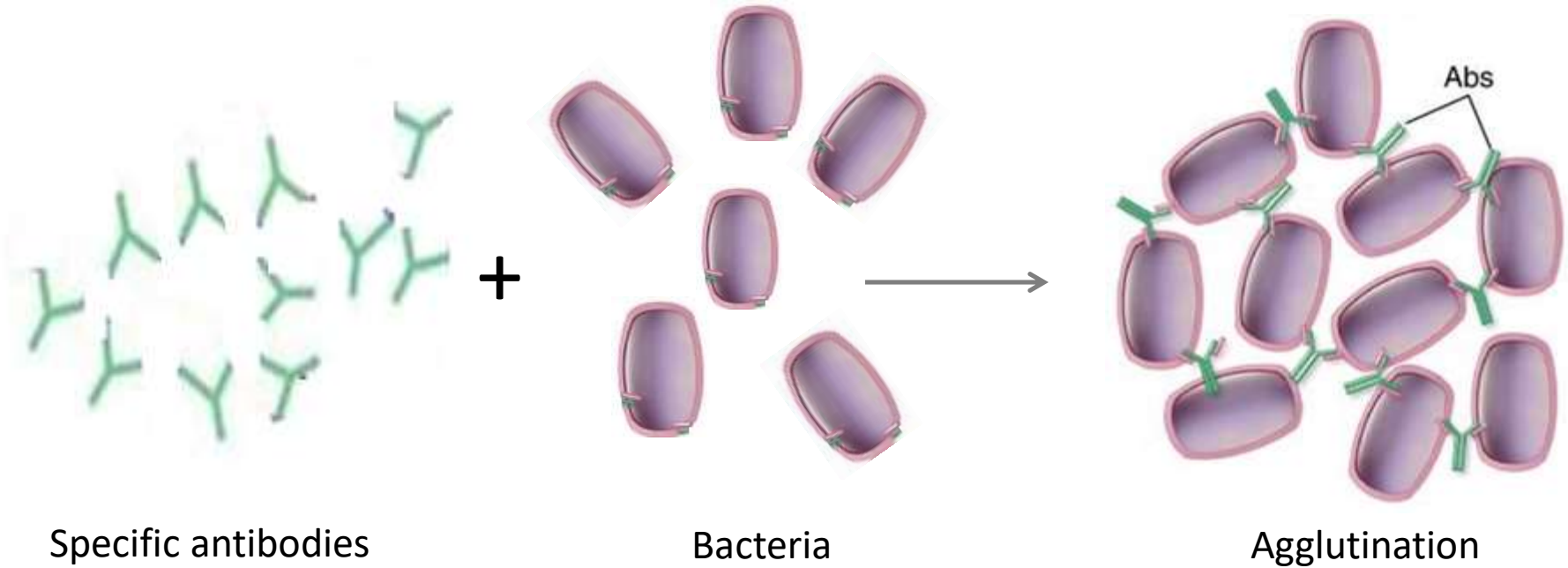




Functions

2. Agglutination. ^{تكتلات}

Is the clumping of large particles



Antibody Classes (isotypes)

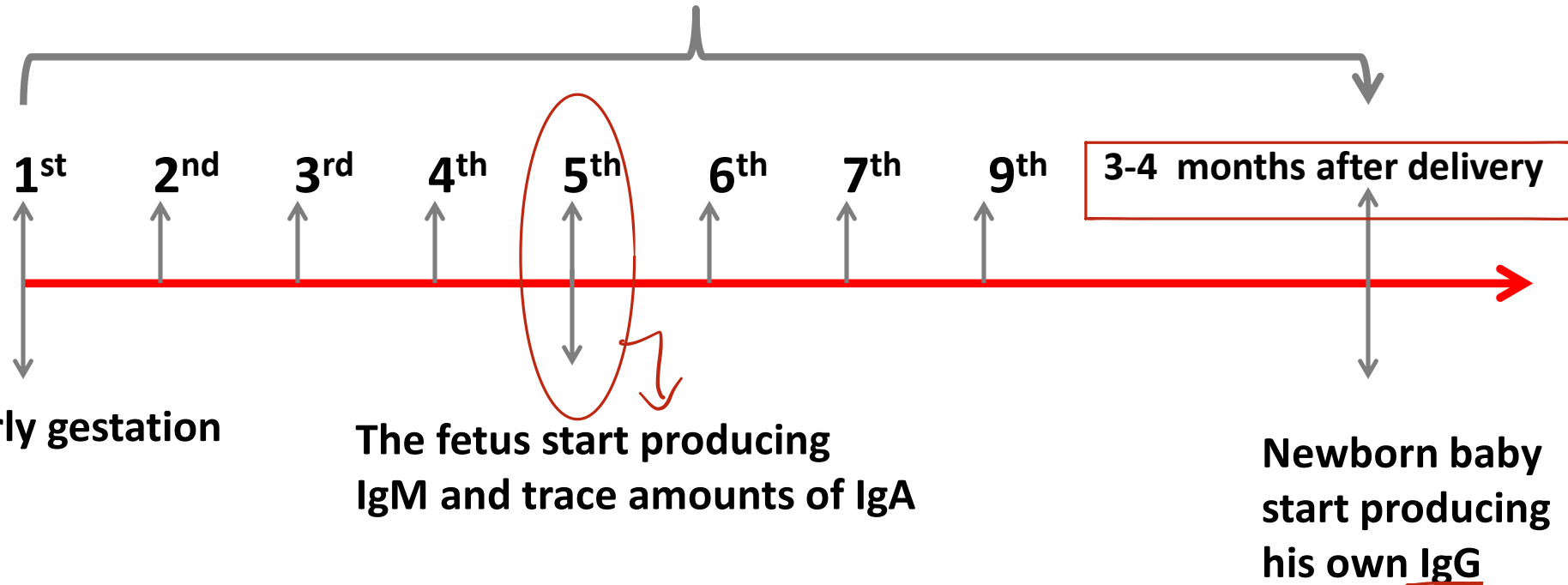


IgG → The only one can pass the placenta

Functions

3. Fetal and neonatal protection

Protection by Maternal IgG

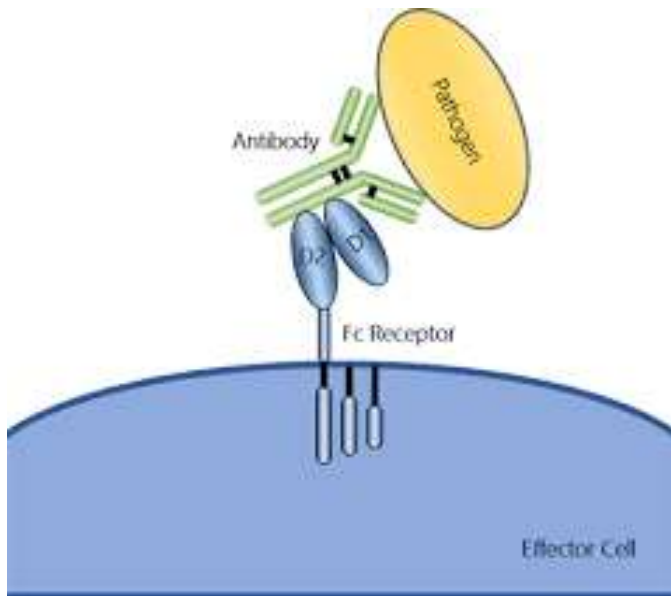
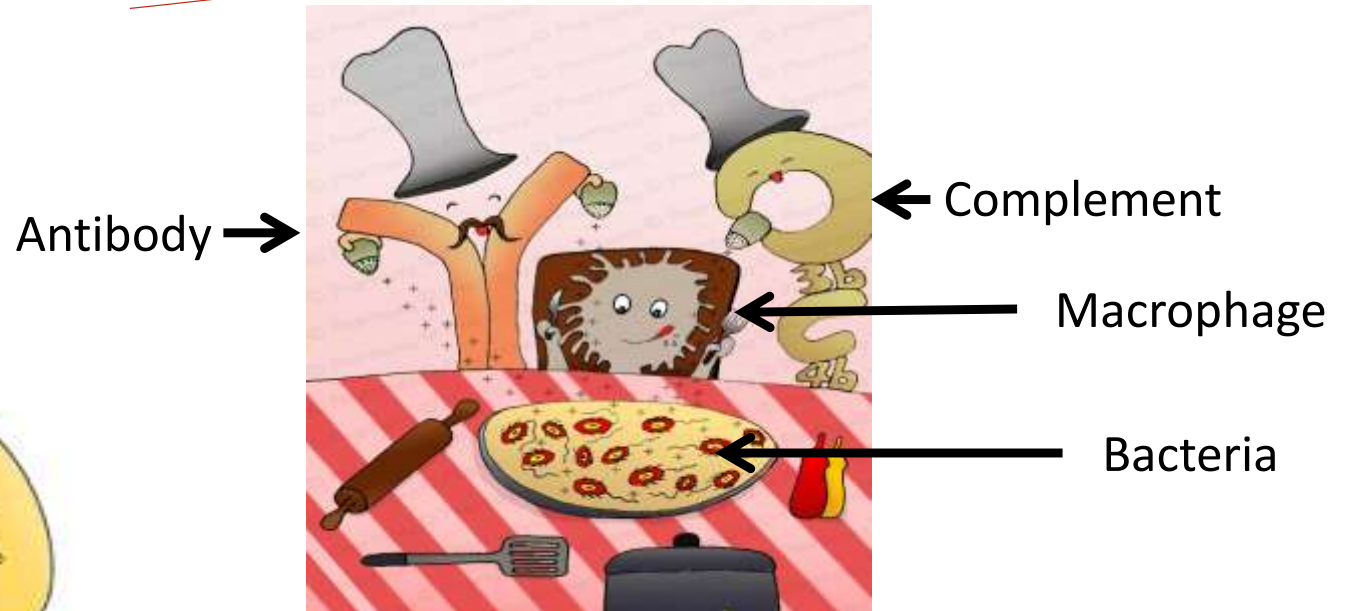




IgG

Functions

4. Opsonization: from Greek to prepare for eating

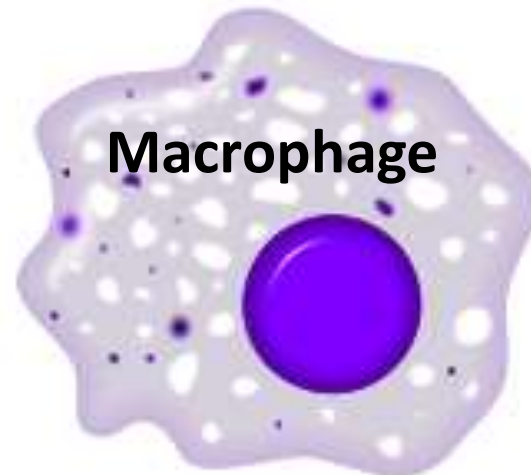
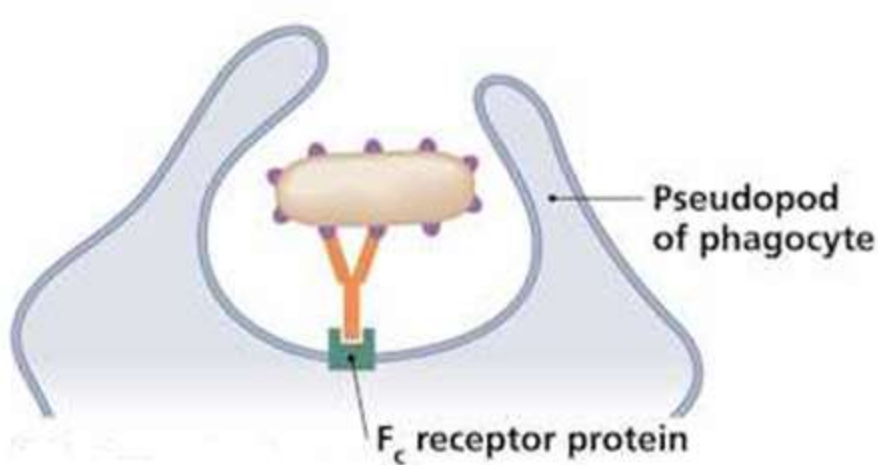
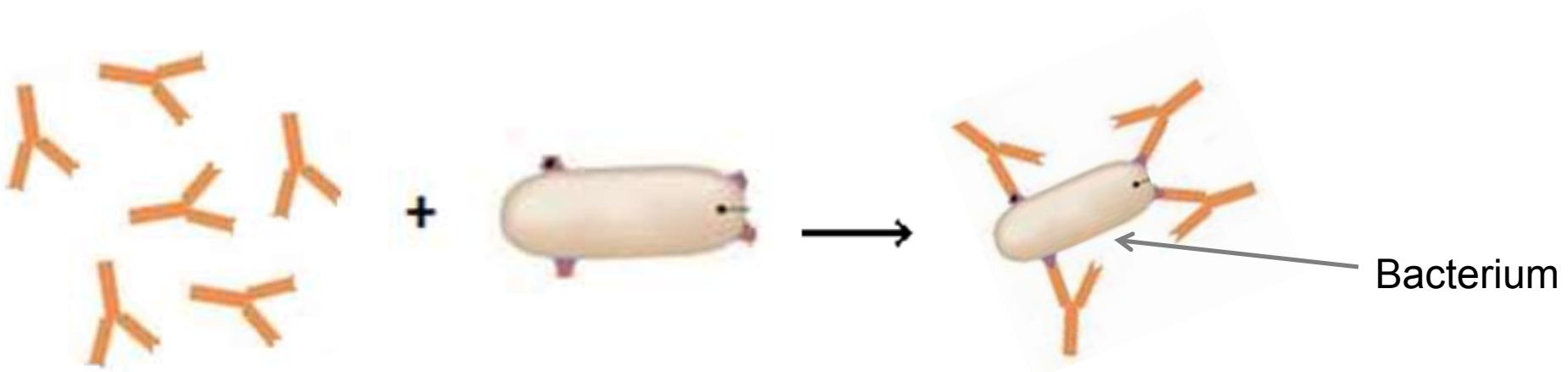




IgG

Functions

4. Opsonization: from Greek to prepare for eating



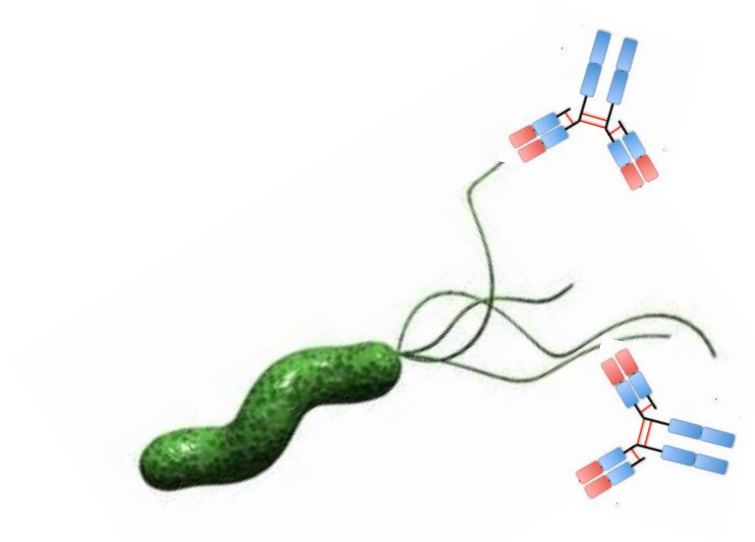
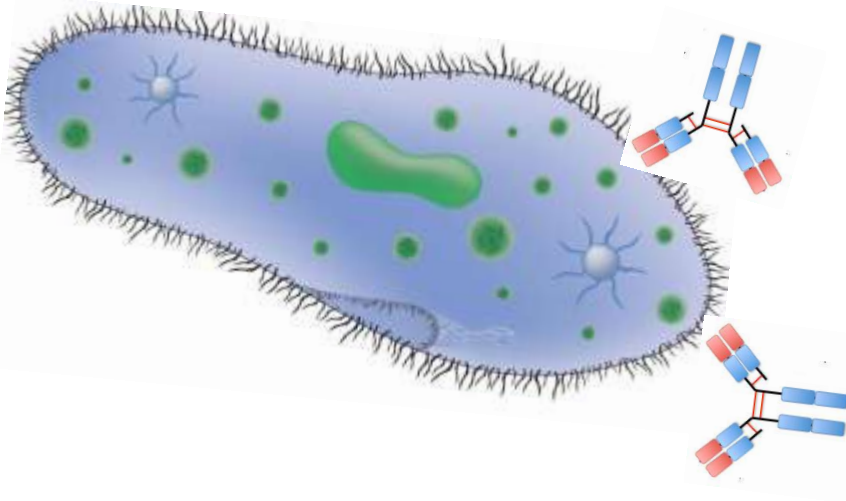


IgG

Functions

5. Immobilization of bacteria

paramecium



Helicobacter pylori

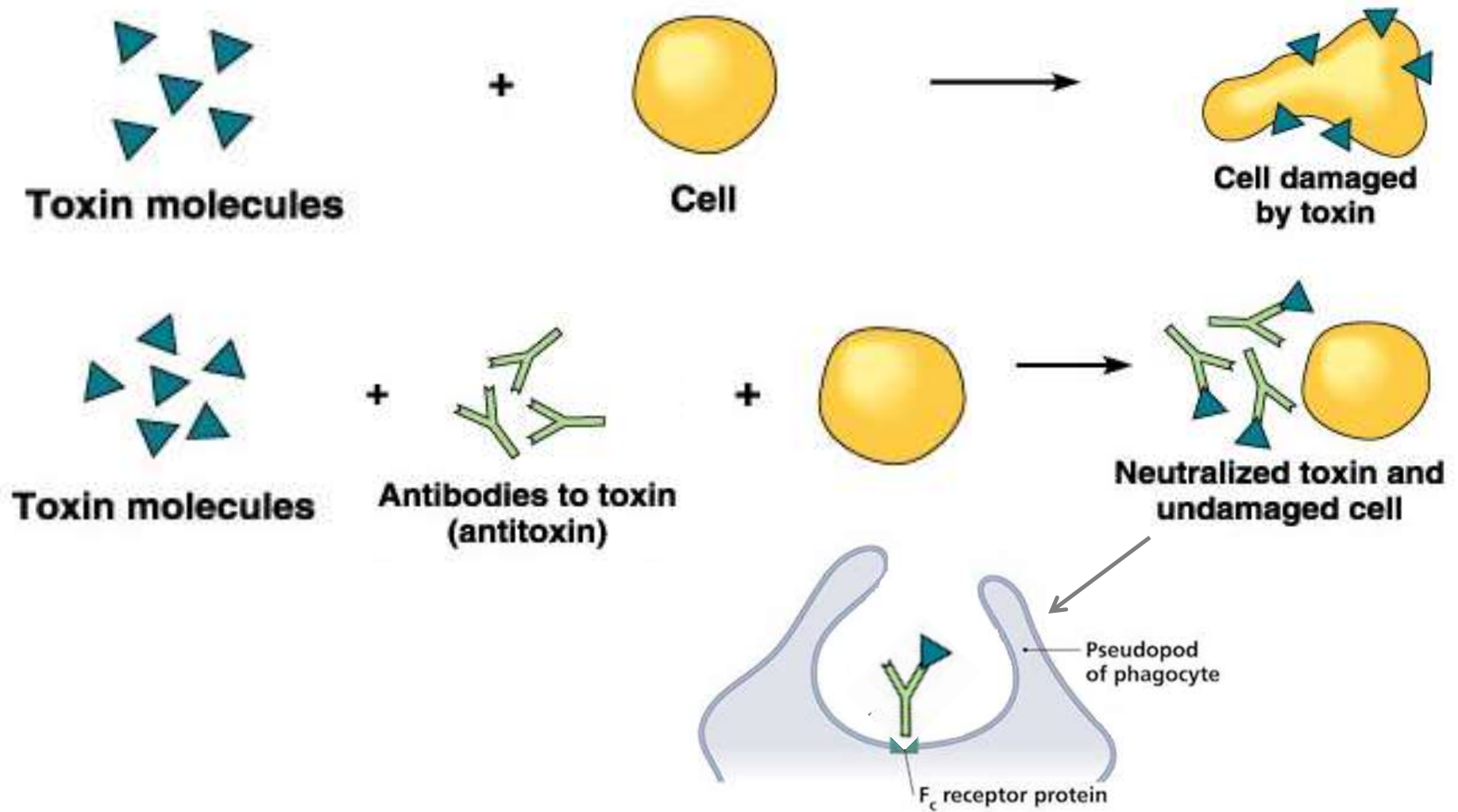
Antibodies against cilia and flagella leave them immotile



IgG

Functions

6. Neutralization toxins



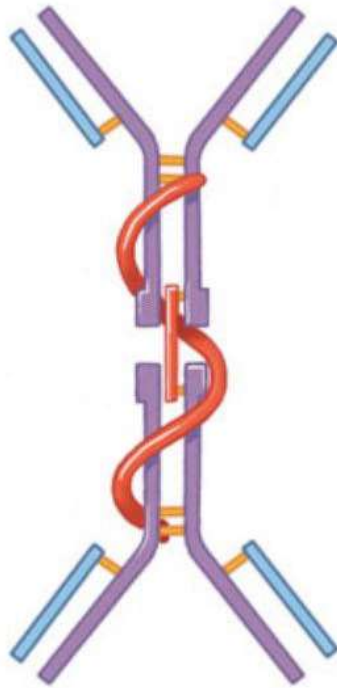
Antibody Classes (isotypes)



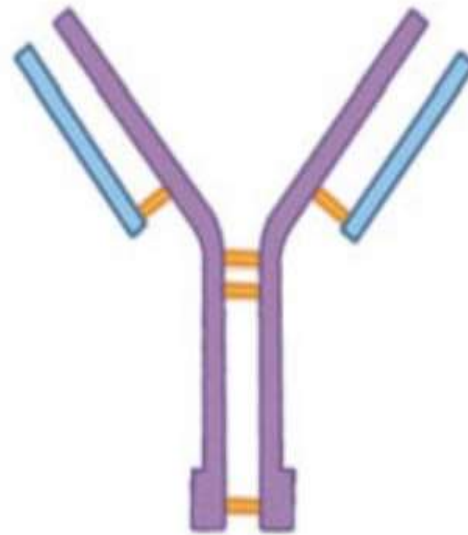
IgA *⇒ produced by plasma cells*

Forms

Plasma cells produced and released two forms of IgA



Dimeric IgA



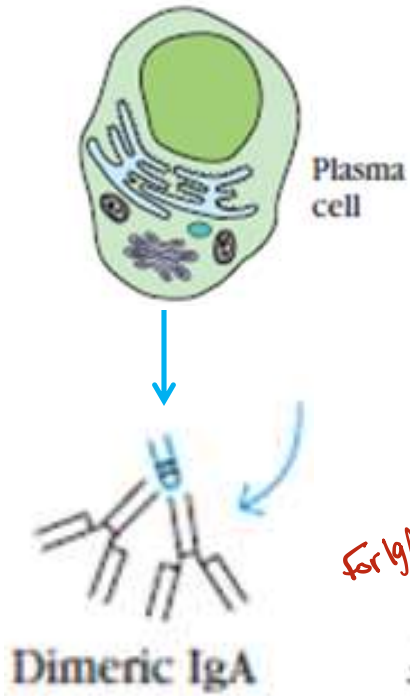
Serum IgA: has a monomeric form with unknown function

Antibody Classes (isotypes)

IgA

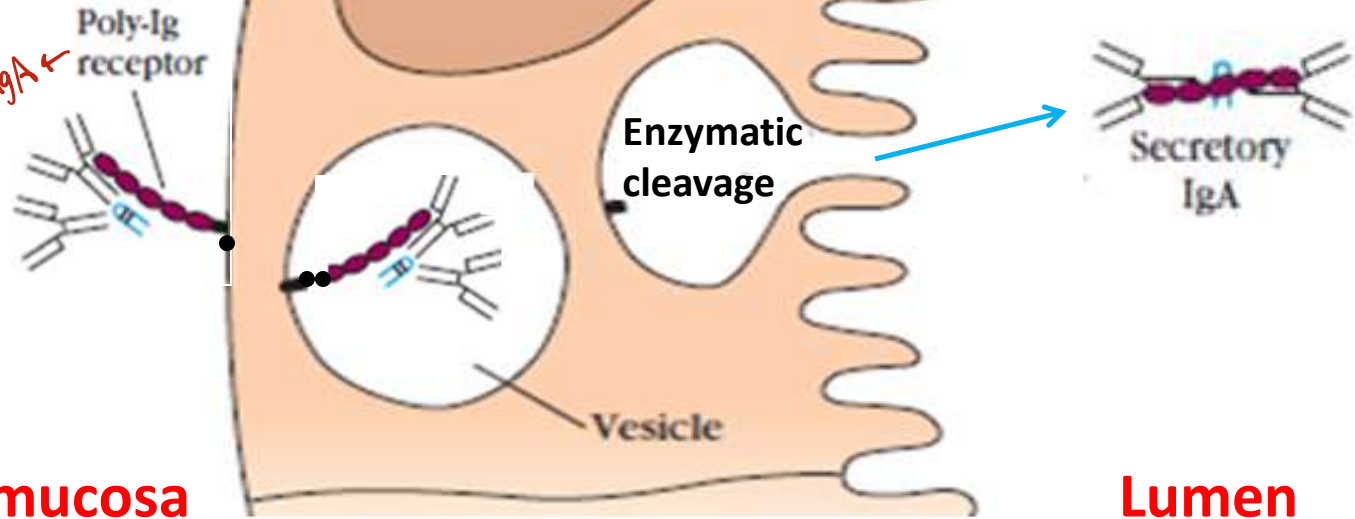
Formation of secretory IgA

** 4 Antigen binding sites.*



For IgA ←

Poly-Ig receptor



IgA

Functions:

- Provides neonates a protection against respiratory and GIT infections
- Efficient antiviral and agglutinating Ab
- Cannot fix complement
- Half-life 6 days

Antibody Classes (isotypes)

Out with stool

IgA

Salmonella



Lumen

Intestinal epithelium

M cells

in Peyer's patches

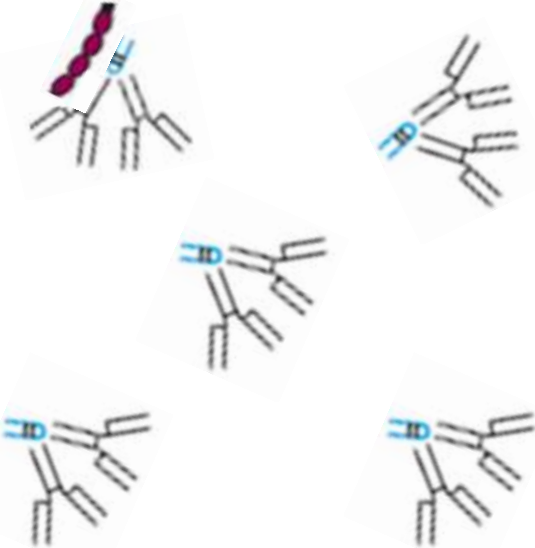
APC

T

B

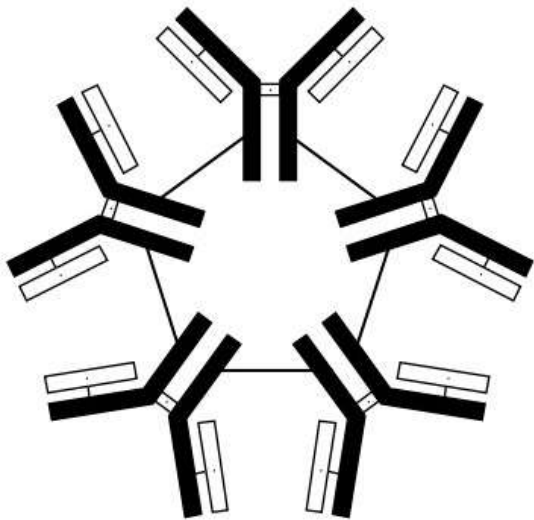
Peyer's patches

Submucosa



Antibody Classes (isotypes)

IgM \Rightarrow S



The first Ab produced in response to an antigenic stimulation

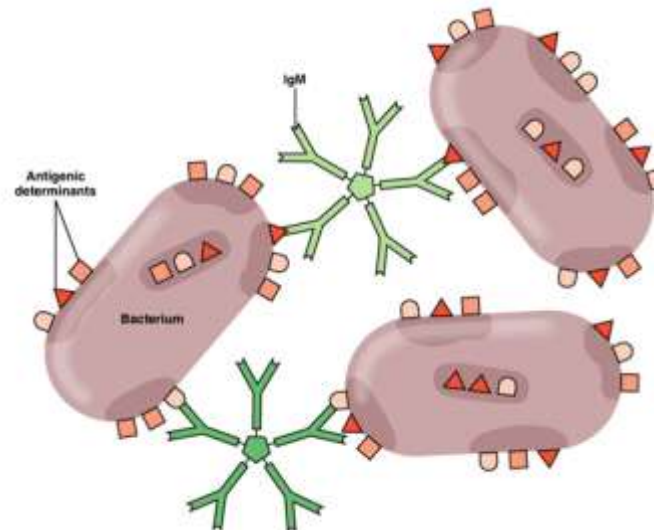
The half life is 10 days

First Ab produced after 5 months of gestation

Efficient agglutinating and complement fixing Ab



Cannot pass placenta



Antibody Classes (isotypes)

IgD

Have unknown protection function

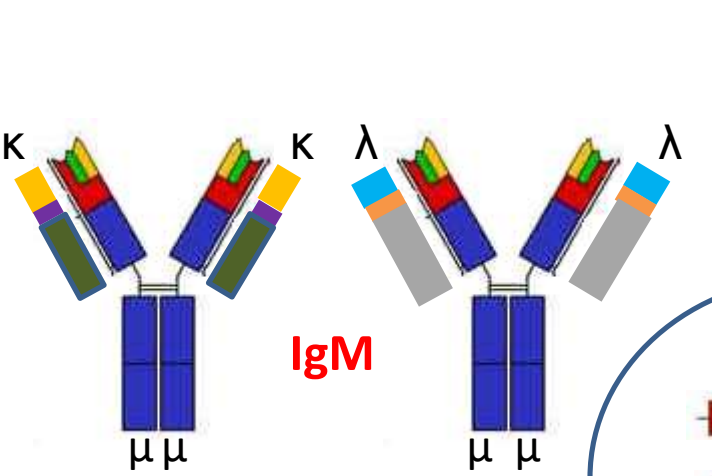
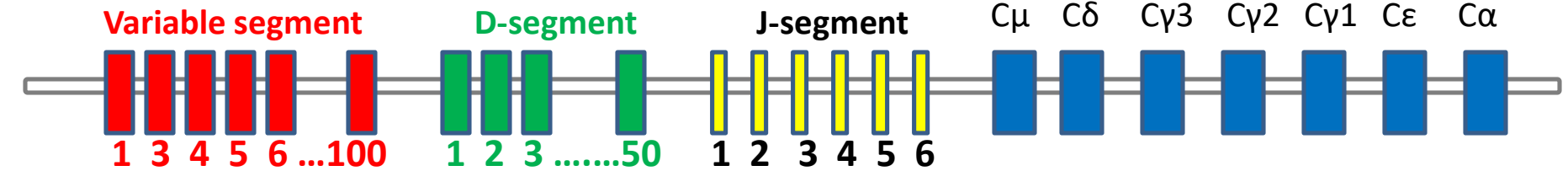
IgE

- Not agglutinating and complement fixing Ab
- Increasing levels of IgE in serum have been shown to occur during infections with certain parasites
- Has a high affinity receptor on the surface of eosinophils
- Associated with hypersensitivity or allergy reactions
- Half life is 2 days

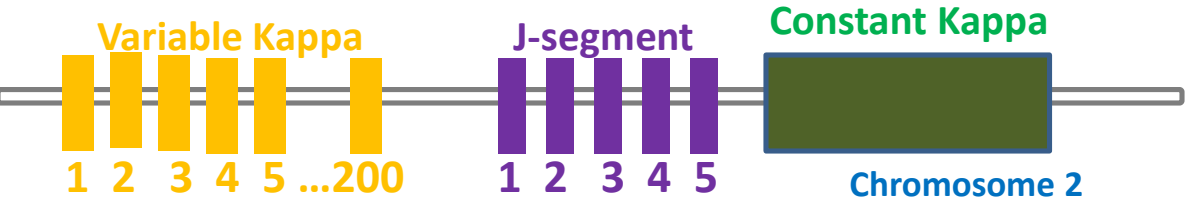
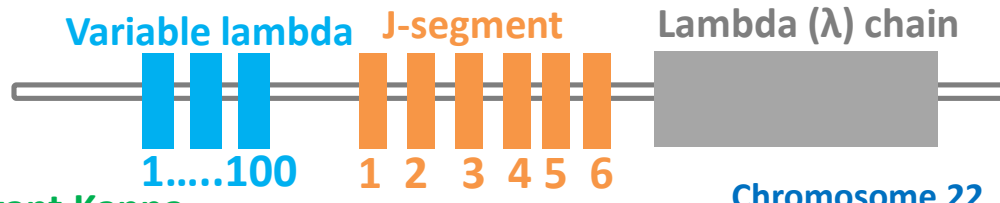
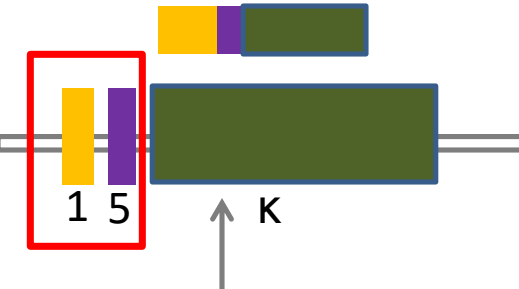
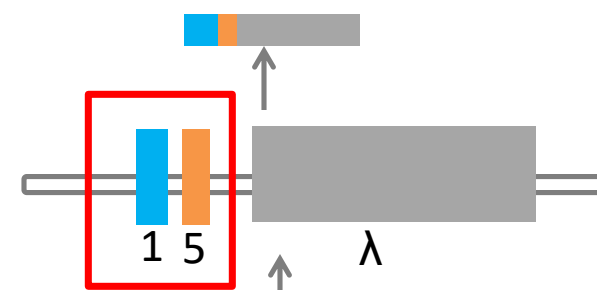
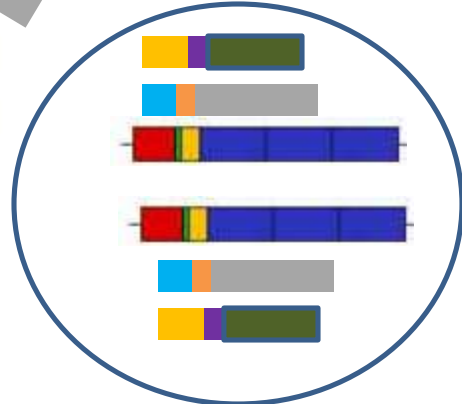
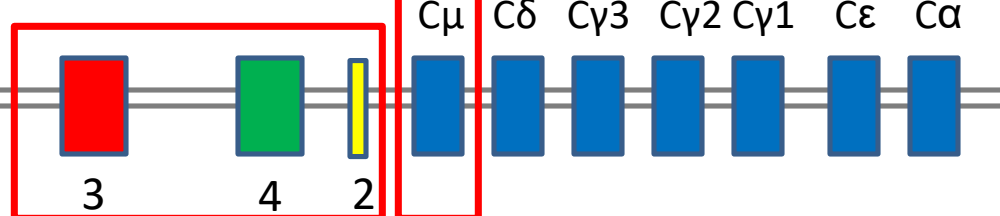
Why do we have millions of different versions of Fab?

light heavy

Chromosome 14



Recombinases



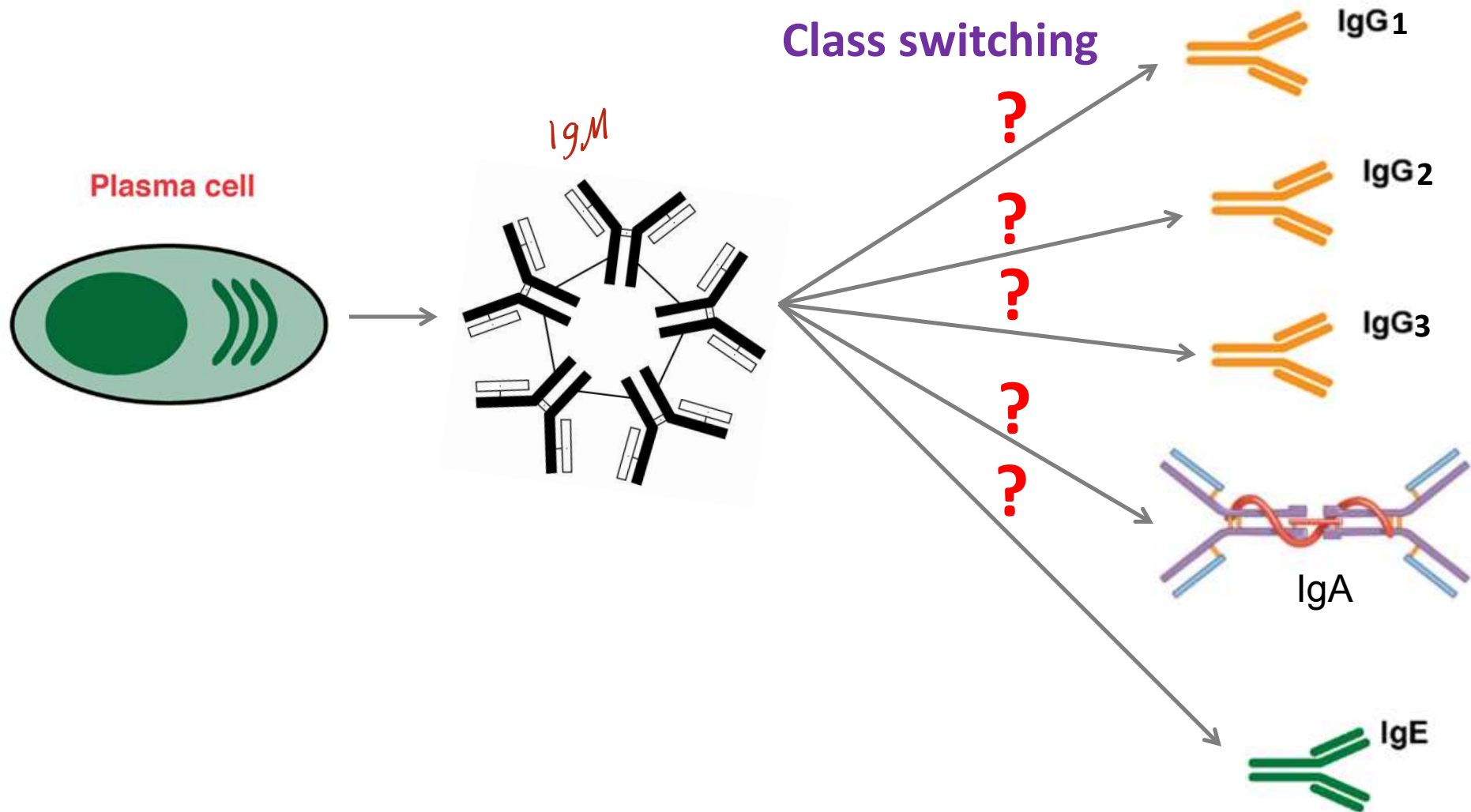
Light chains

Chromosome 22

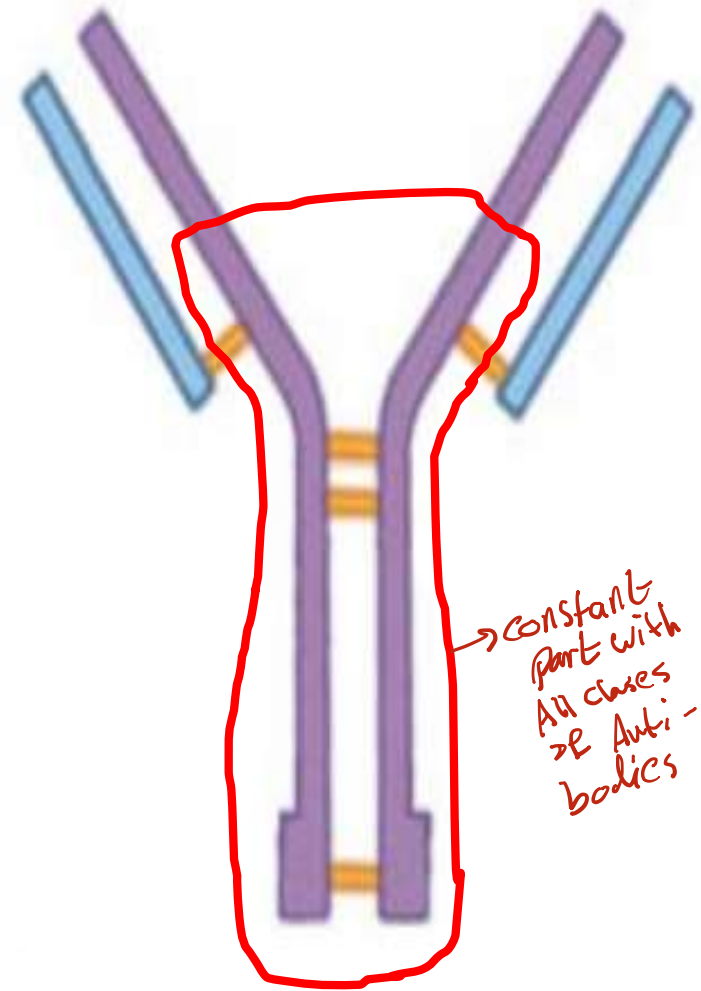
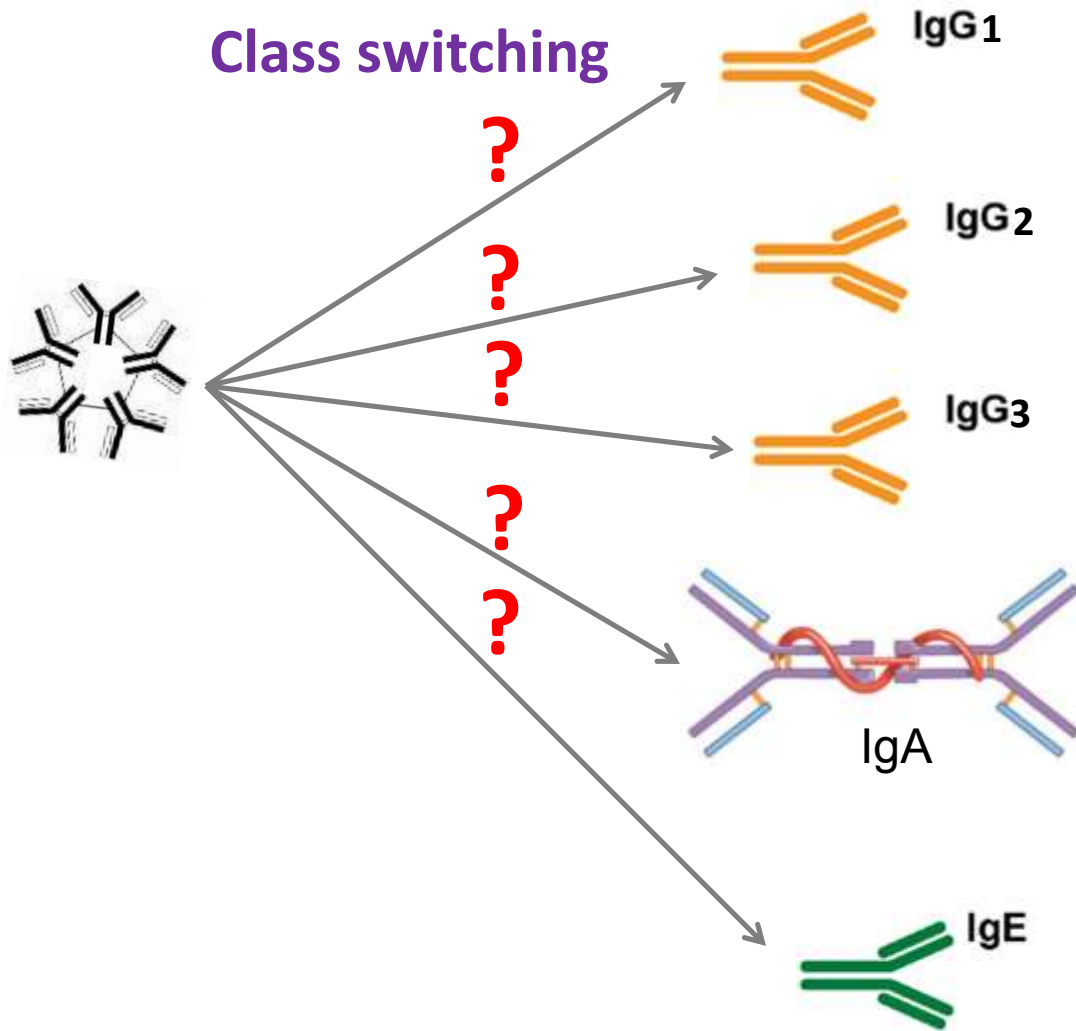
Chromosome 2

The process of class switching

How to produce more than type of antibodies from one response?

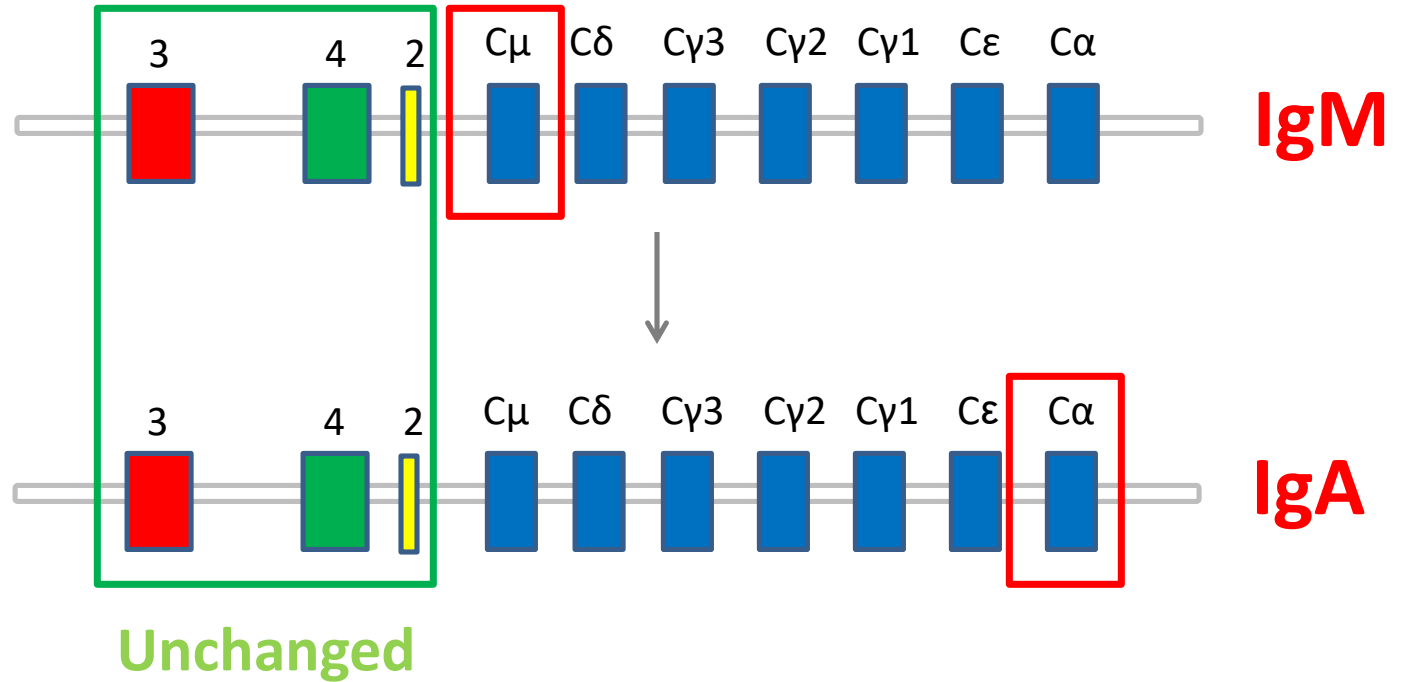
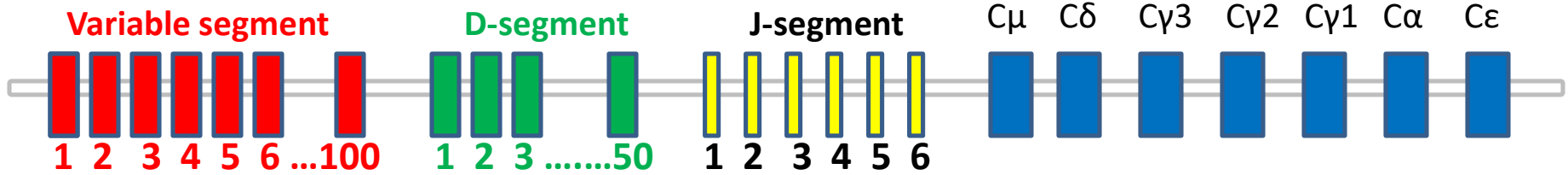


The process of class switching



Class switching is determined only by change in the type of the constant region

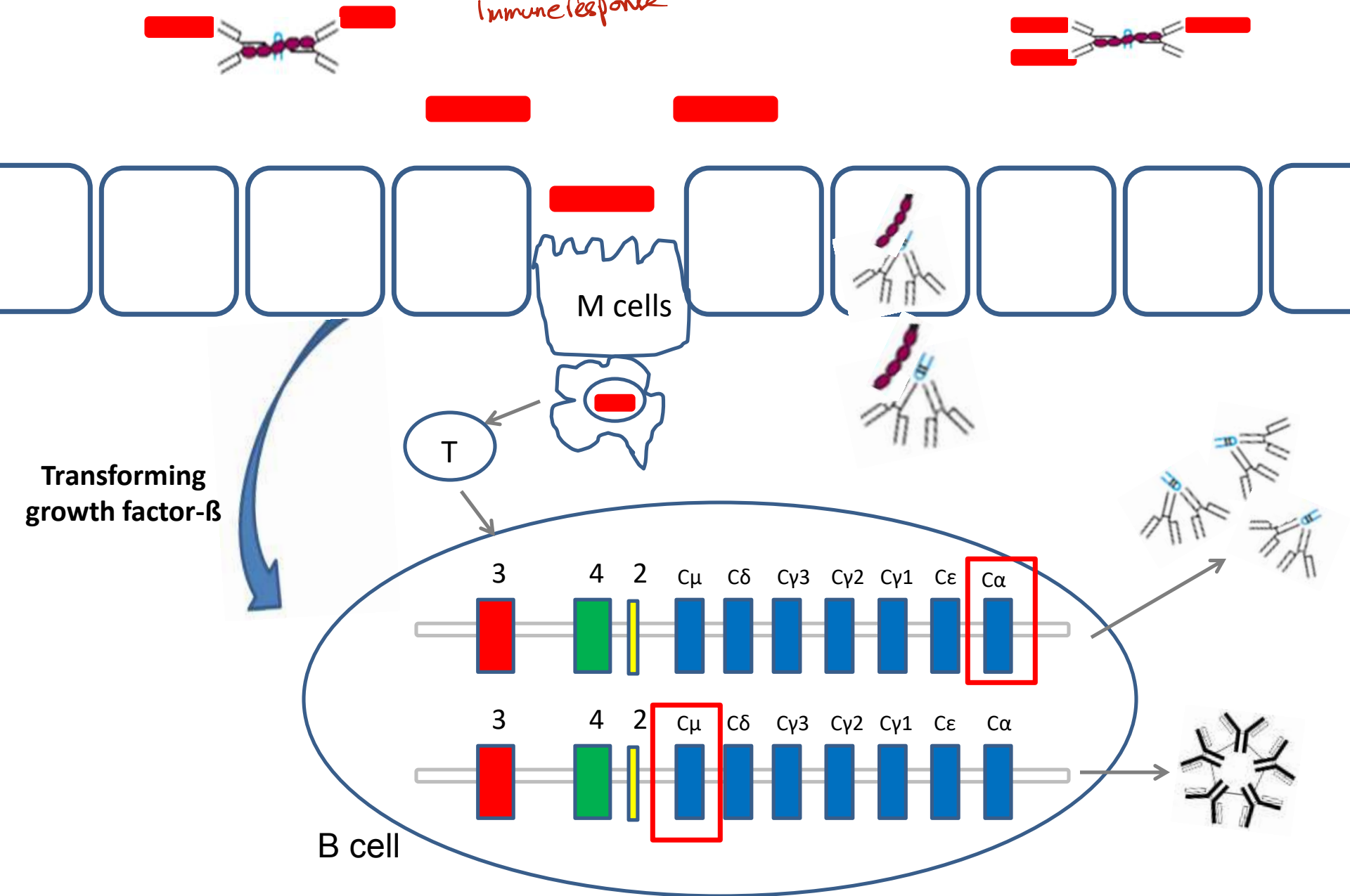
The process of class switching



More than one type of antibodies from one response

IgM to IgA

In primary
Immune response

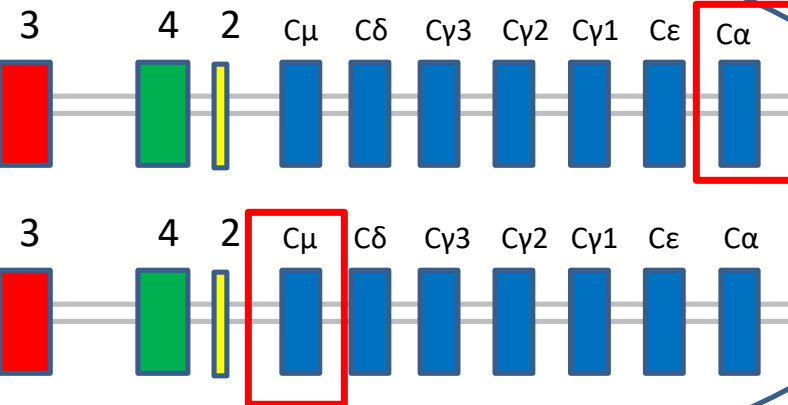


Transforming growth factor- β

M cells

T

B cell

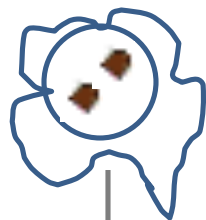
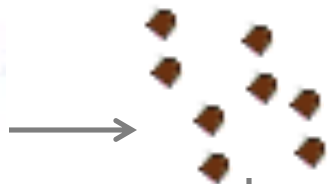


IgM to IgE

↳ NOT beneficial in parasitic infections

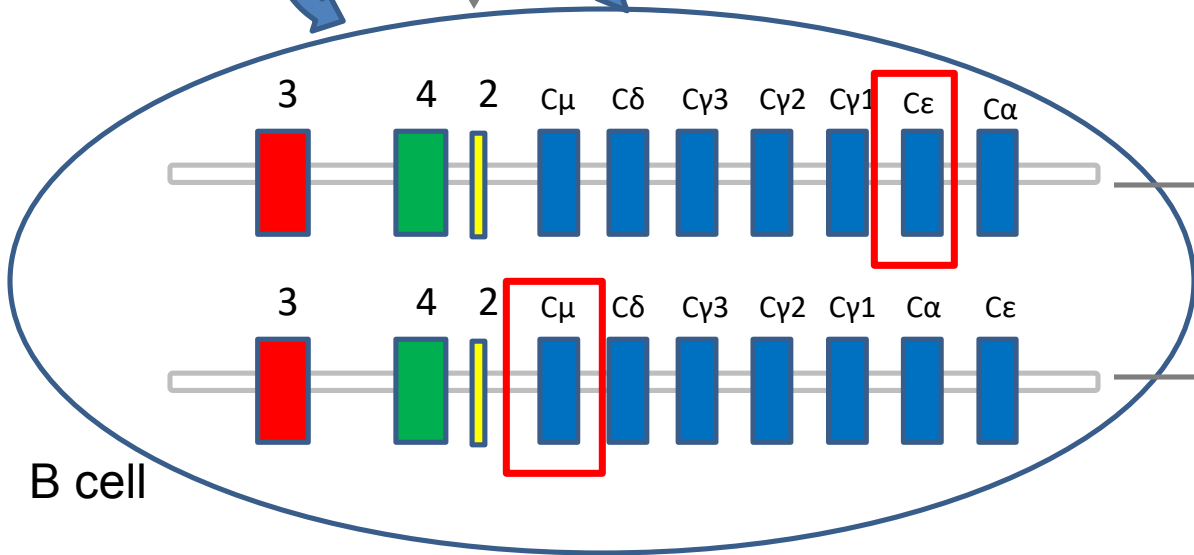


Helminth



IL-4
IL-5

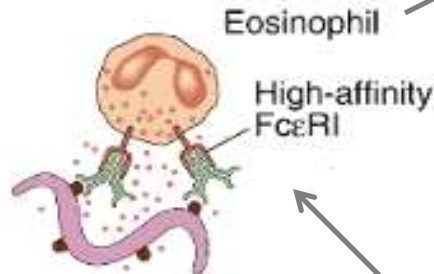
IL-13 *→ do class switching from μ to ϵ .*



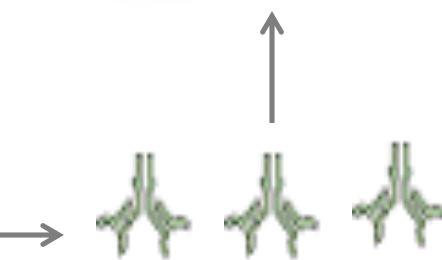
Some are died and antigens are released in tissue



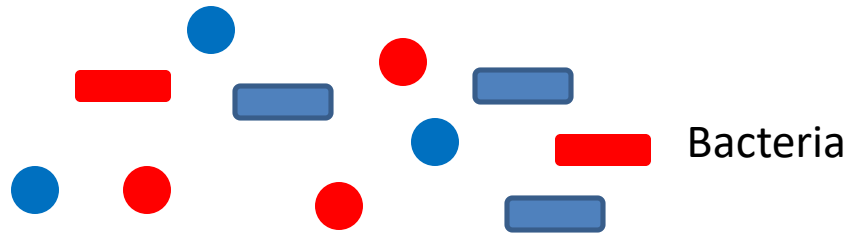
Killing of helminth



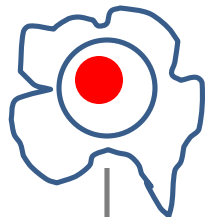
Eosinophil
High-affinity FcεRI



IgM to IgG1



Bacteria



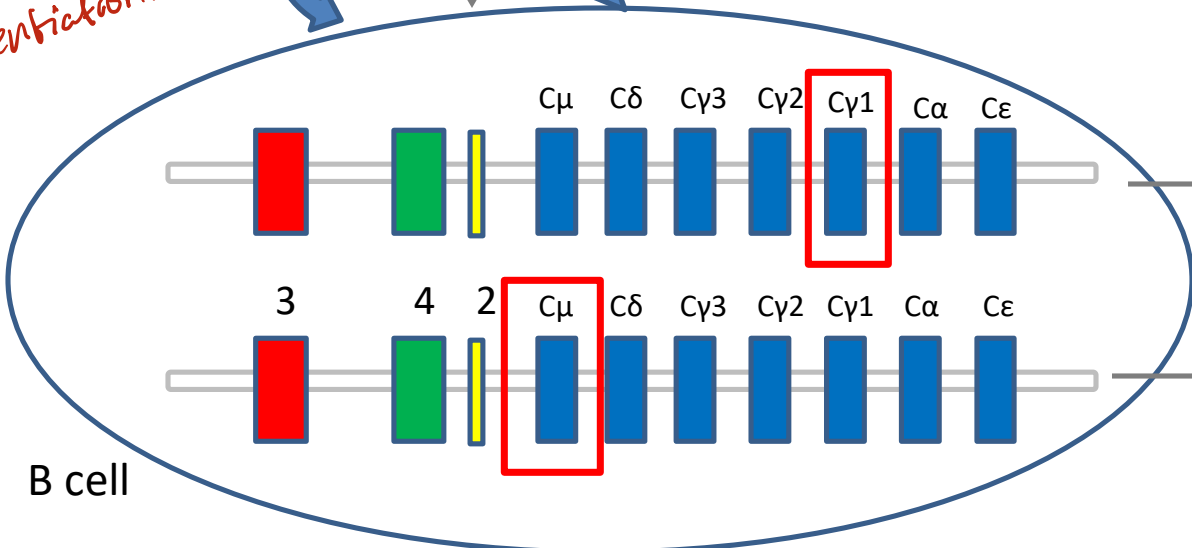
T

IL-4
IL-5

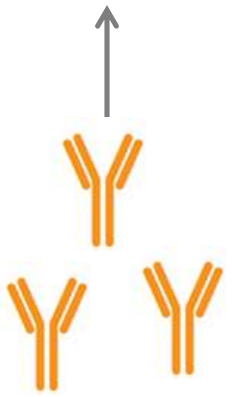
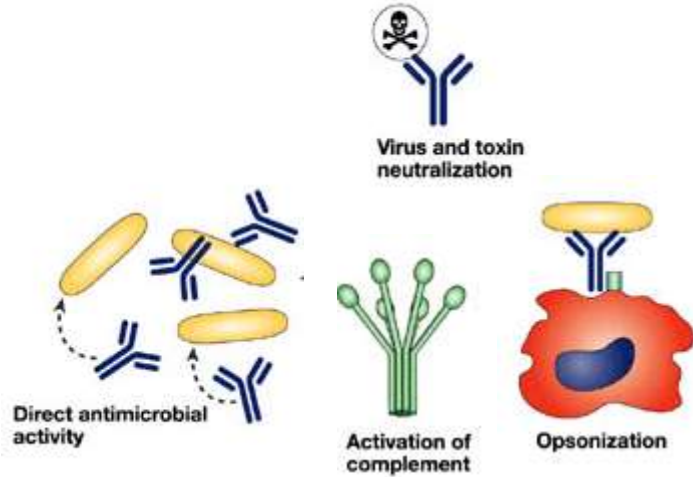
IL-4

class switching from γ to μ .

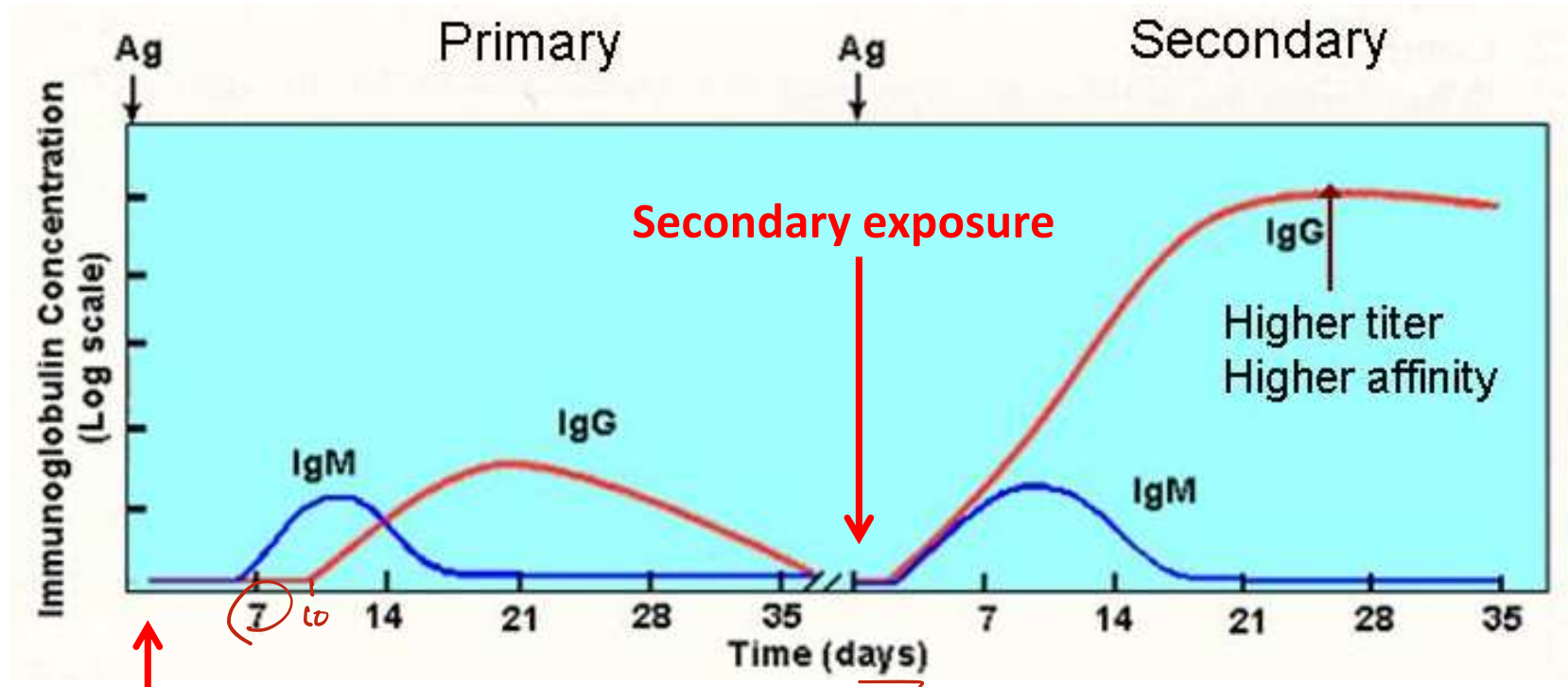
Do proliferation & Differentiation.



B cell



Kinetics of antibody response following immunization



Primary exposure