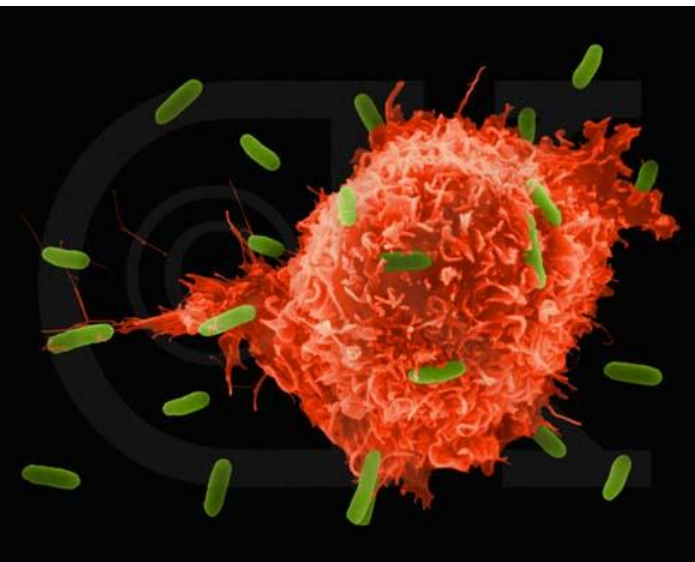# Introduction to the Immune System

Dr. Issa Abu-Dayyeh

Why is Immunology difficult??

1- Details

MAIN DECK

Darrow: As I remember it, after a complicated drawing like this, Larry and Andy would let me draw something a little easier and go back and forth to avoid being too flabbergasted by it all. The Deck took a very long time, and I wouldn't let them see it until I finished it. There's a catwalk that goes up above, and I told Larry and Andy there should be three or four of these catwalks, but if I draw them all in, you won't be able to see all of the chairs because of the perspective. It bothered me, because it looks odd that there is only one of these catwalks, and should be more. But they did it—it was built with all of the catwalks.
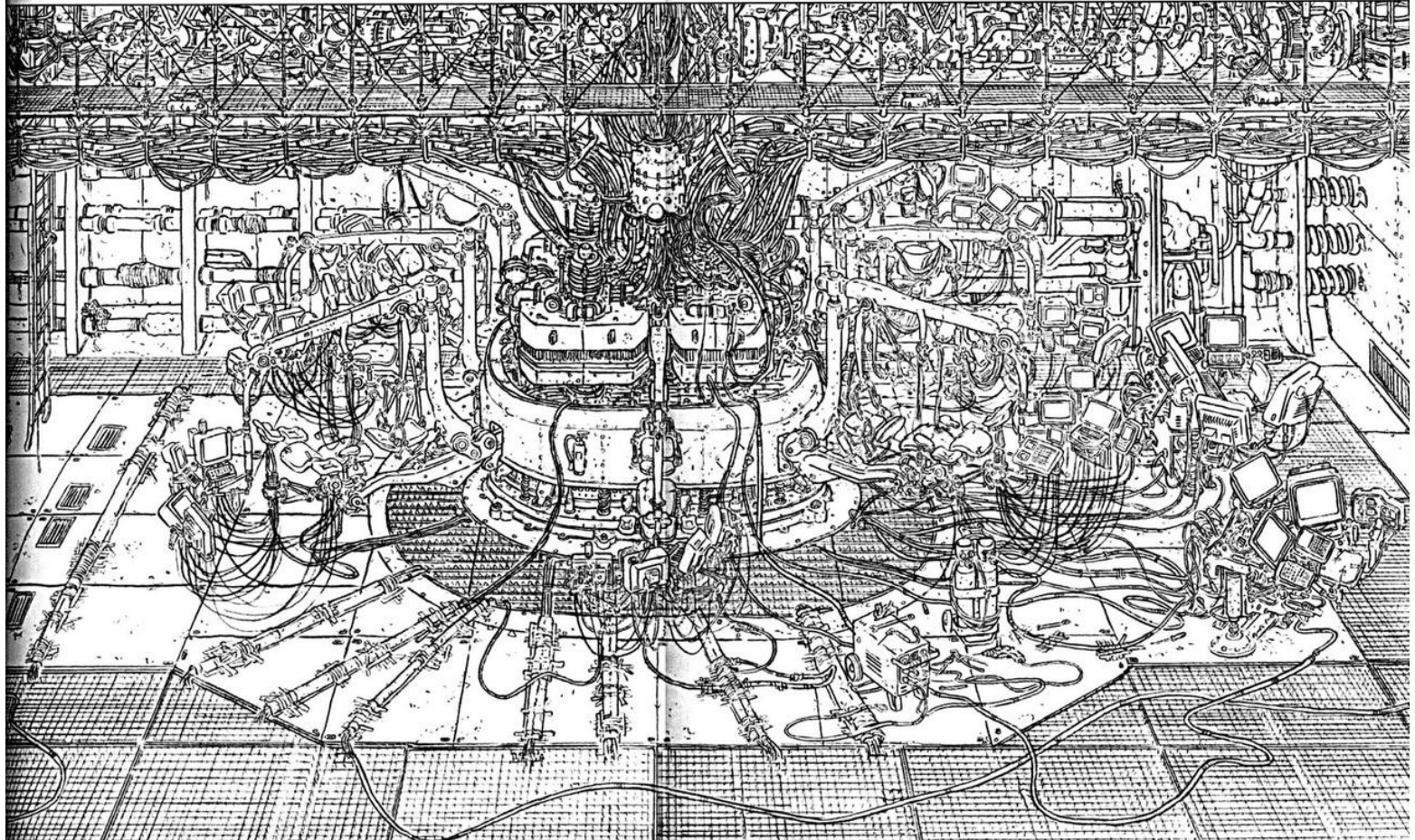
2-Exceptions
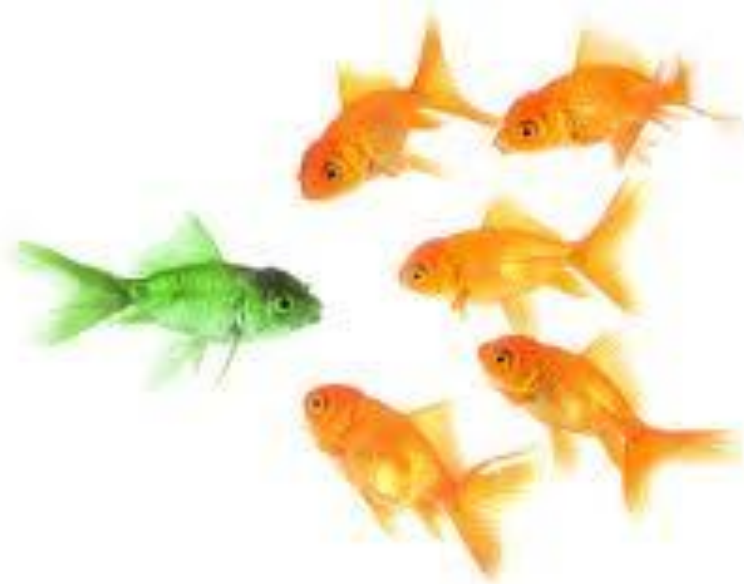
3-An evolving science

4-A network!

The Immune system

First line of defense??

Physical Barriers!

Skin ($2m^2$)

Mucosal membranes ($400m^2$)
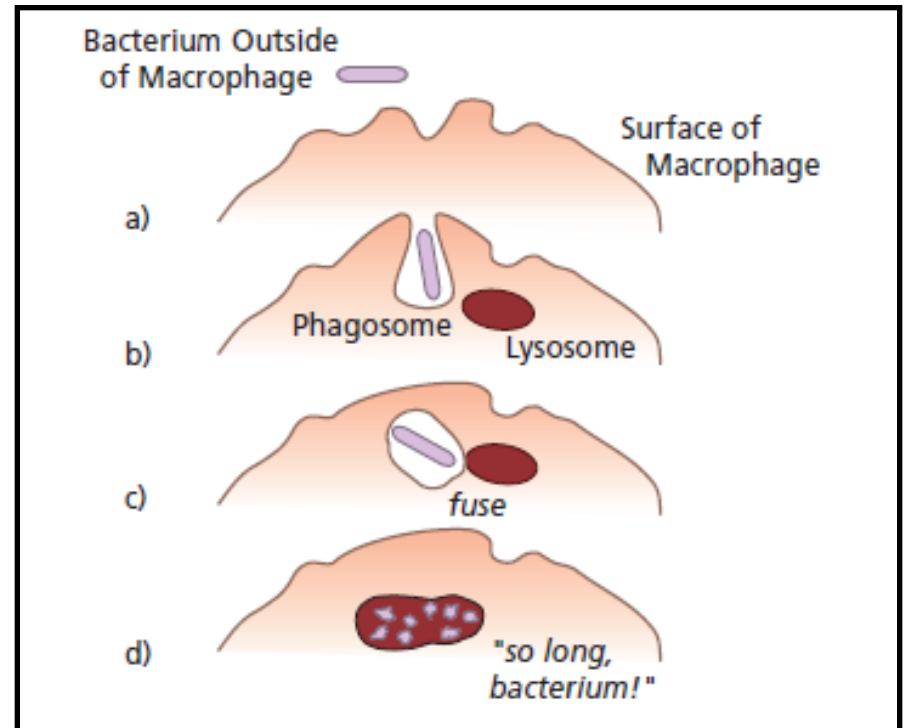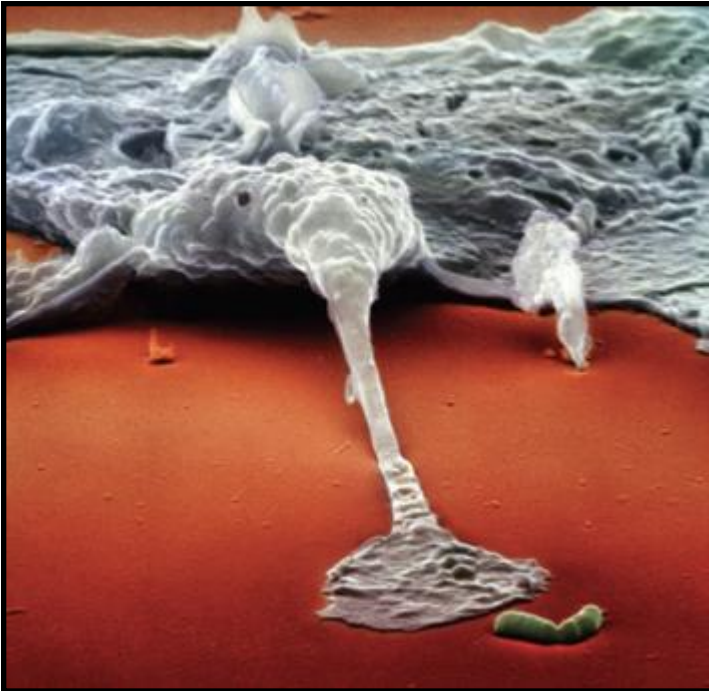
Innate Immune System
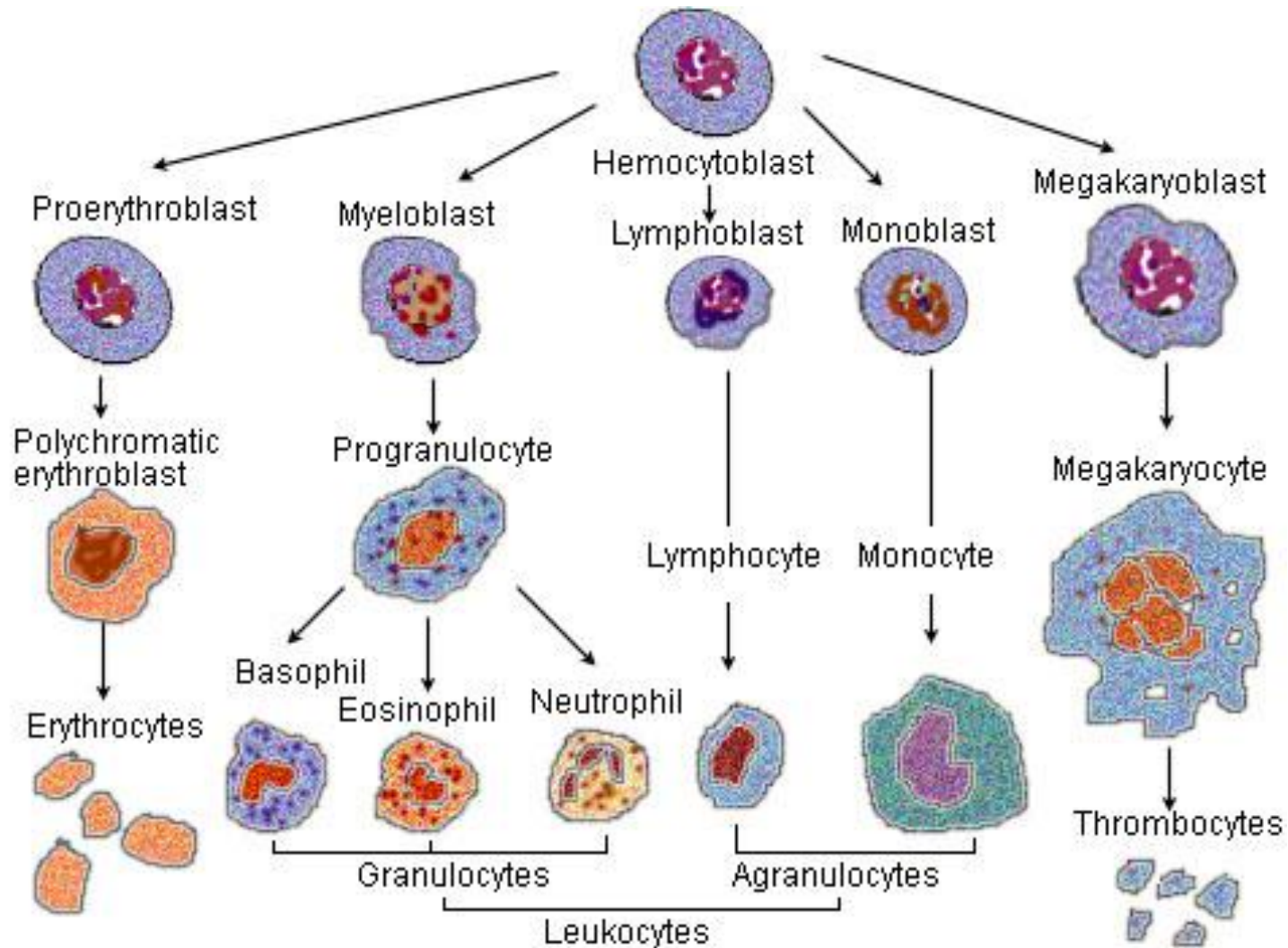
Second line of defense.

500 million years old!

Erythema and edema

The Macrophage

Where do Macrophages and other immune cells come from?

Bone Marrow

Third Line of Defense??

Adaptive Immune System

Adaptive Immune system
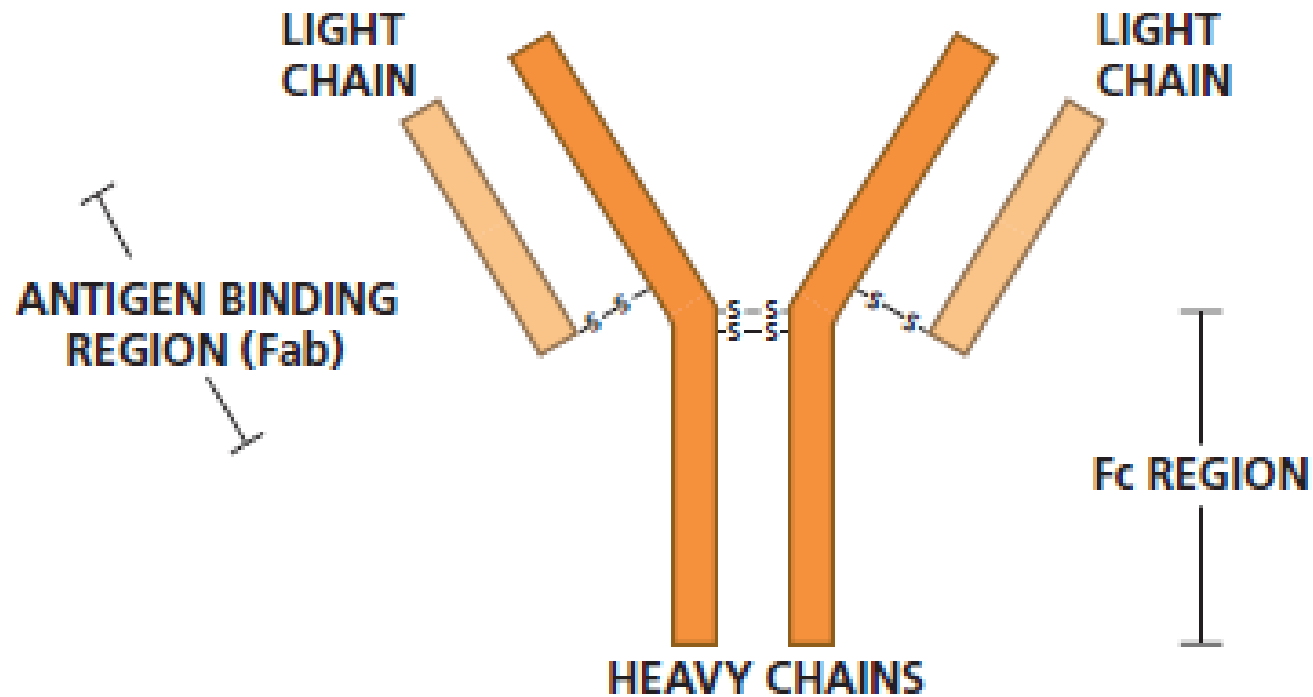
Most probably developed to protect us against viruses

Edward Jenner 1796 Experiment.
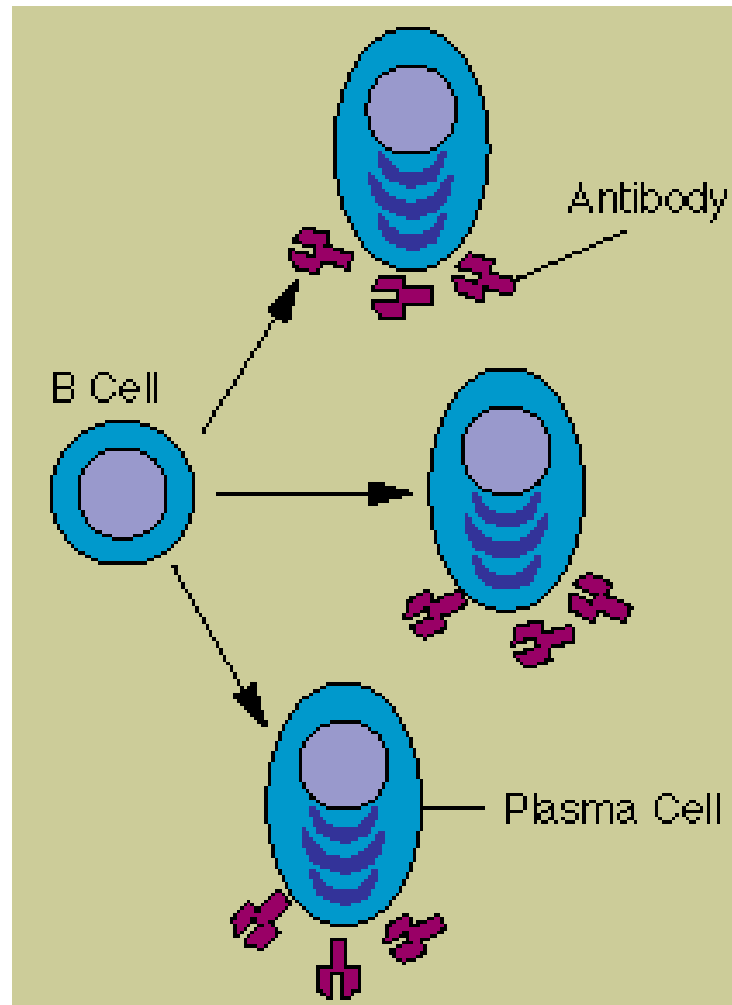

DR. JENNER INOCULATING HIS SON.

After the Sculpture by Professor Monteverde, of Rome, exhibited in the Paris Exposition of 1878.

What causes immunity to smallpox??

Antibodies!!

B cells Produce Antibodies
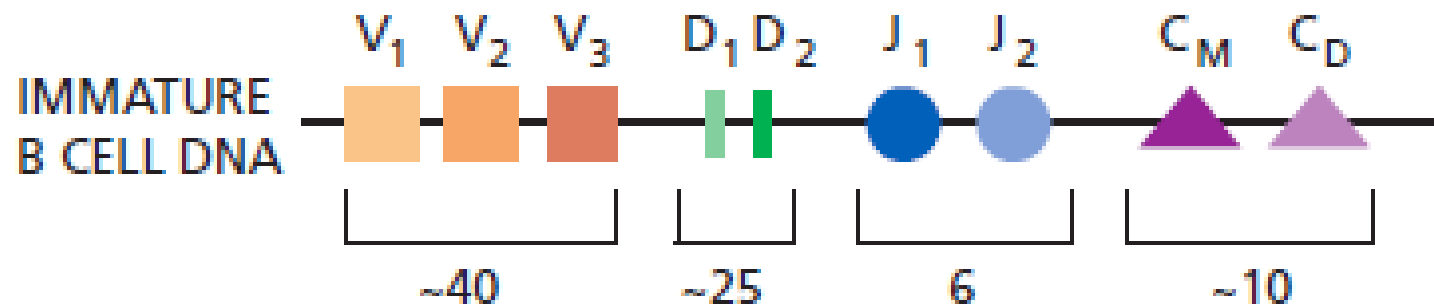
Generating Antibody Diversity

- Around 100 million different antibodies are needed to cover antigen variety.

- 10,000 heavy chain genes mixed with 10,000 light chain genes.

- Total of 20,000 genes required to generate this diversity.
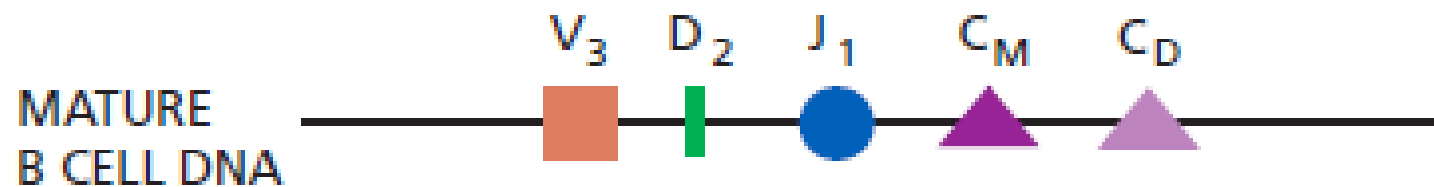
- How many genes do we have???

Riddle Solved!!

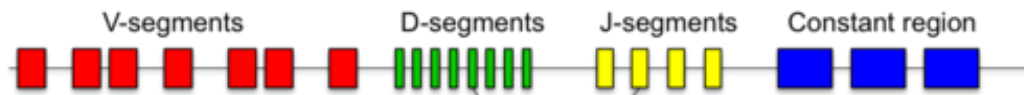

Susumu Tonegawa, 1977

Modular Design

VDJ recombination
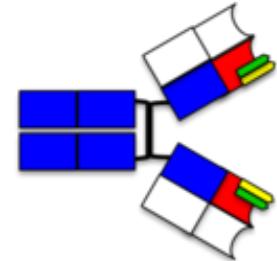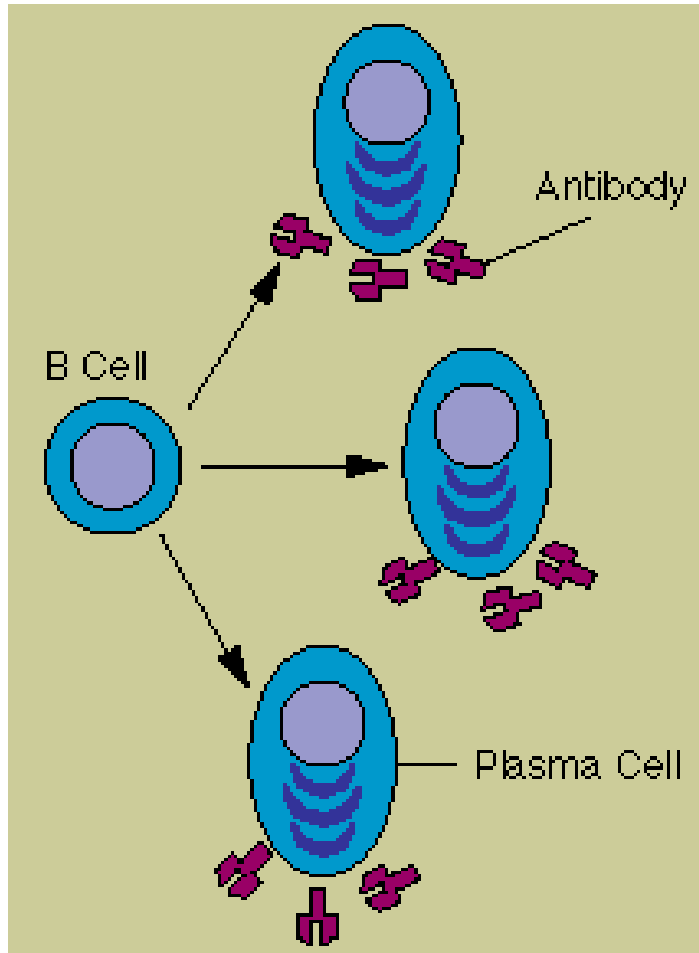
Problem of numbers?

- We have around 3 billion B cells in circulation targeting around 100 million antigens.

- So, 30 B cells per Antigen.

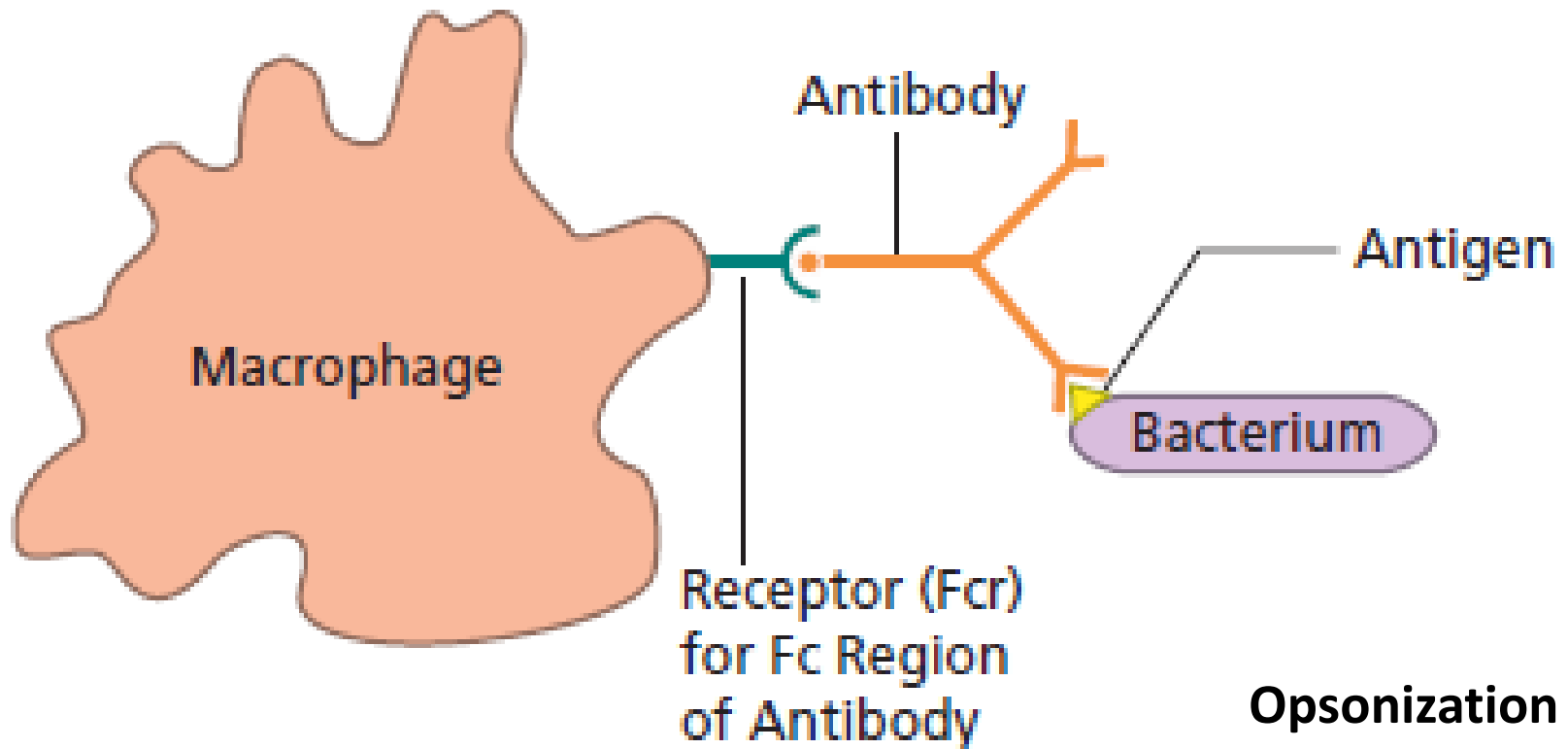- How can we have enough B cells to fight off an infection???

Clonal Expansion

1 cell division/ 12 hours
Within one week......
20,000 B cells secreting the same antibody!!!

One B cell produces around 2000 Abs/sec
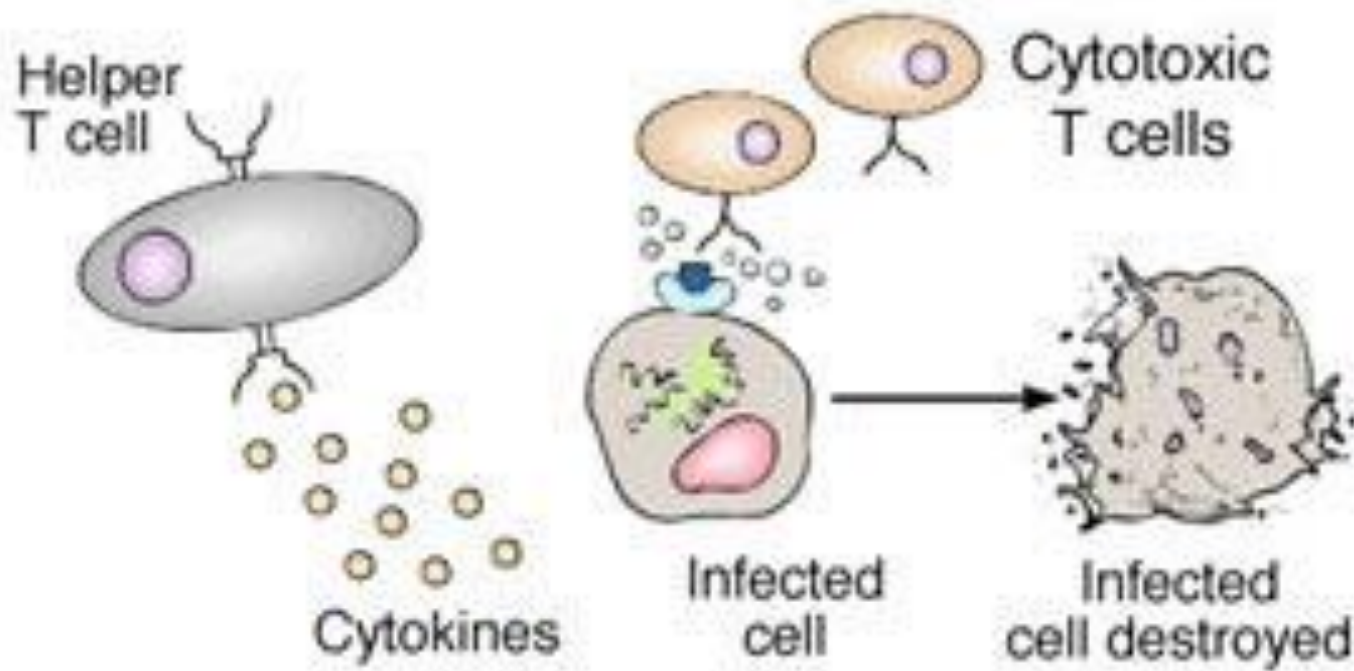
How do Antibodies kill???

Opsonization

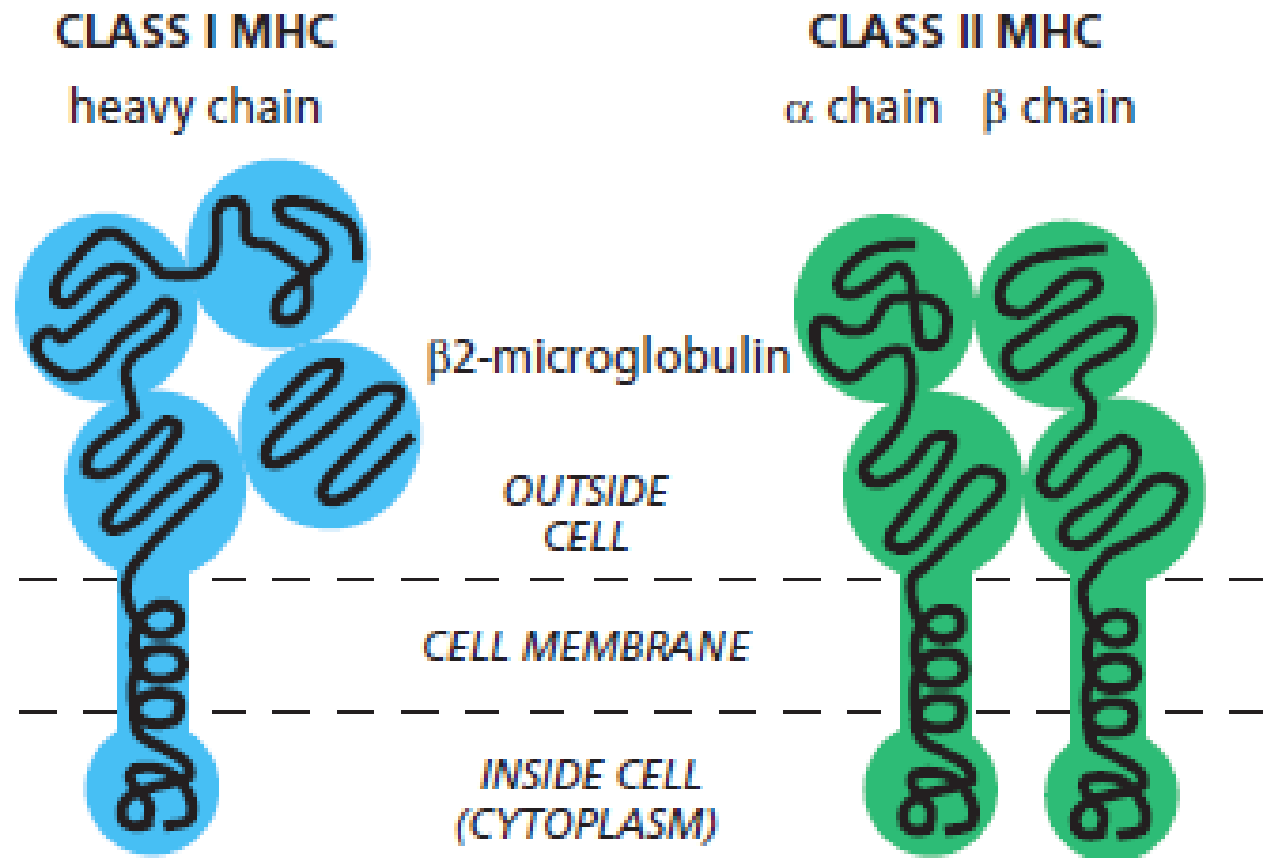Antibodies can block viral replication too!!

T cells

Matures in the thymus
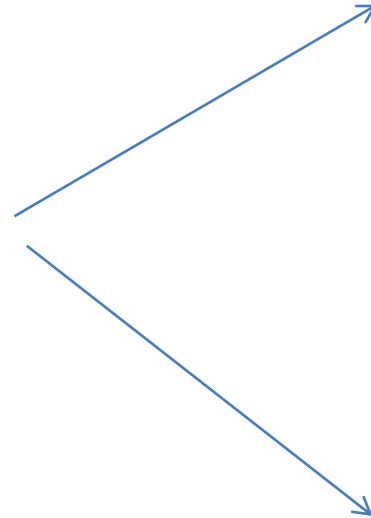Comprises: Cytotoxic T cells, Helper T cells, and regulatory T cells.

How can T cells "see" infected cells?

Antigen Presentation
By APCs.

CLASS I MHC
heavy chain

CLASS II MHC
α chain   β chain

β2-microglobulin

OUTSIDE
CELL

CELL MEMBRANE

INSIDE CELL
(CYTOPLASM)

MHC molecules
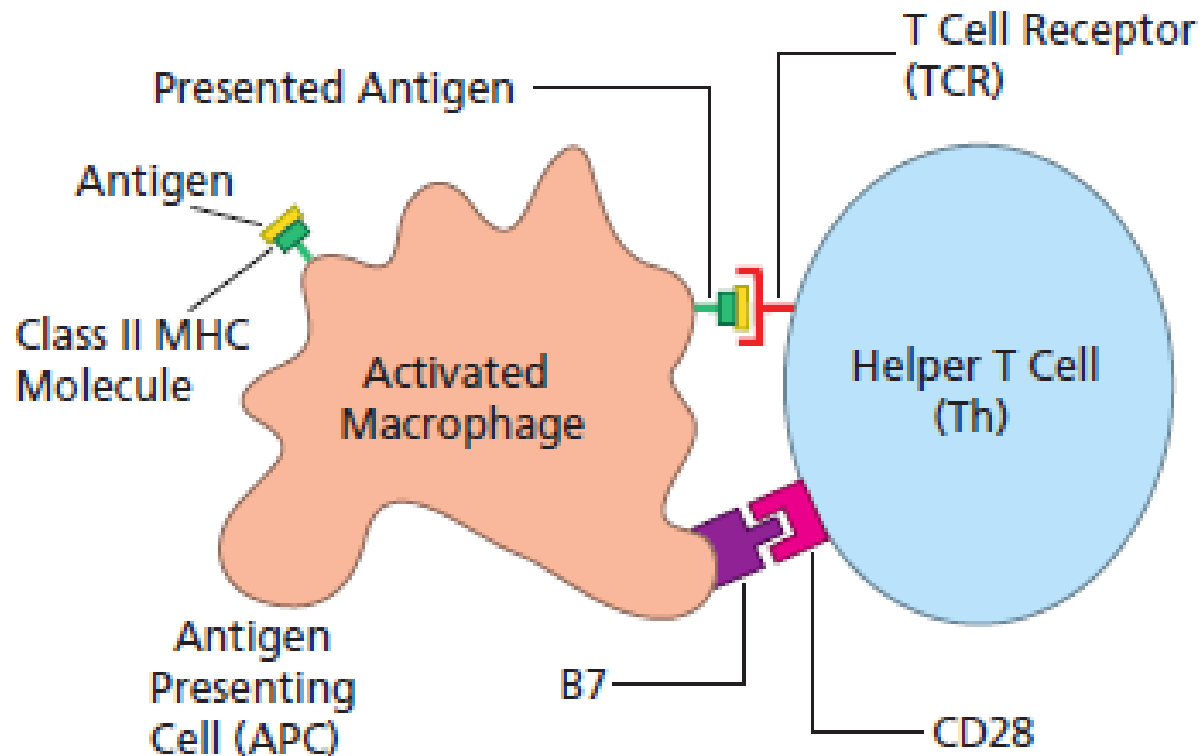

Seen by cytotoxic T cells

~9 a.a

MHC class I

Seen by Helper T cells
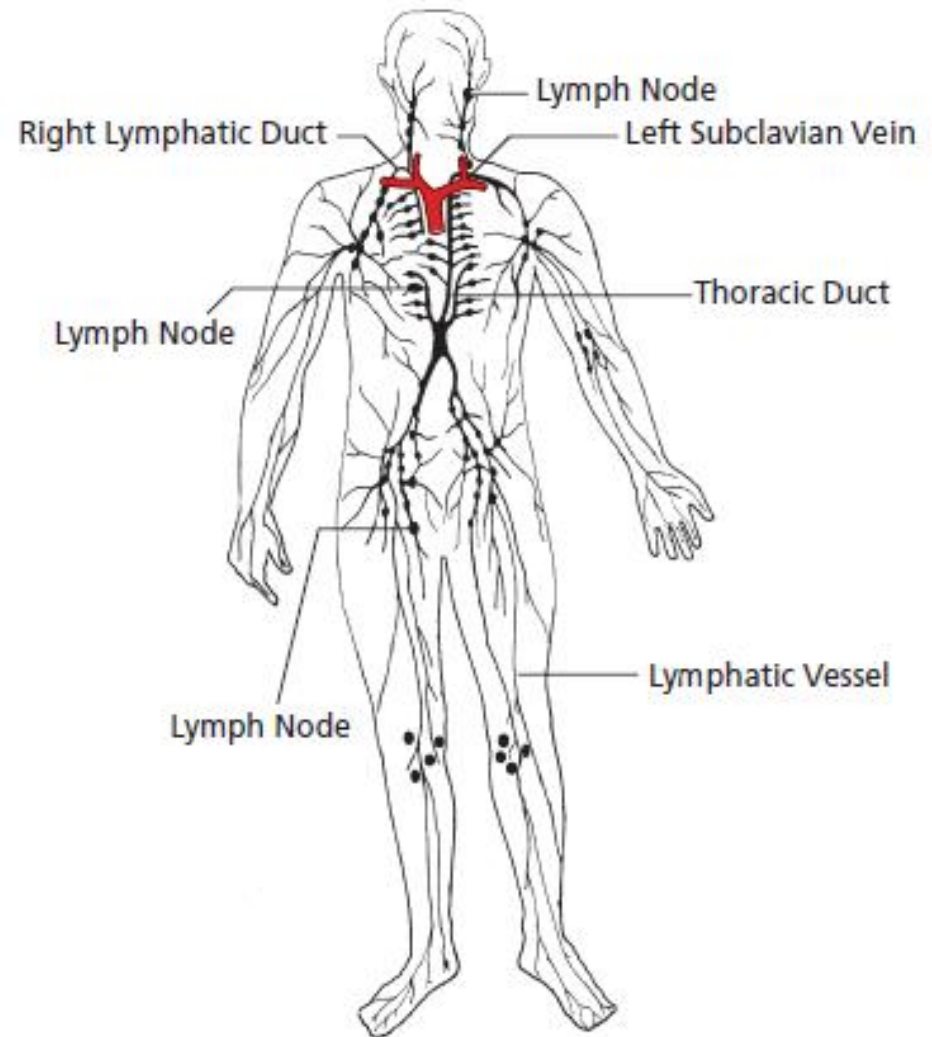
~20 a.a

MHC class II

How can we control lymphocyte activation???

- Two-Key System!!!

How can APCs and lymphocytes meet??

Lymph nodes!!

Innate vs. Adaptive systems

- Innate defends non-specifically and buys time for adaptive immune system to kick in if needed.

- Innate immune system decides which cells should respond, where, and when!

- The innate immune system rules!

THANK YOU!

QUESTIONS??