

# **TYPES OF IMMUNITY**

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# IMMUNITY: AN INTRODUCTION



## ➤ Immunity

Overall ability of host to fight the disease causing organisms

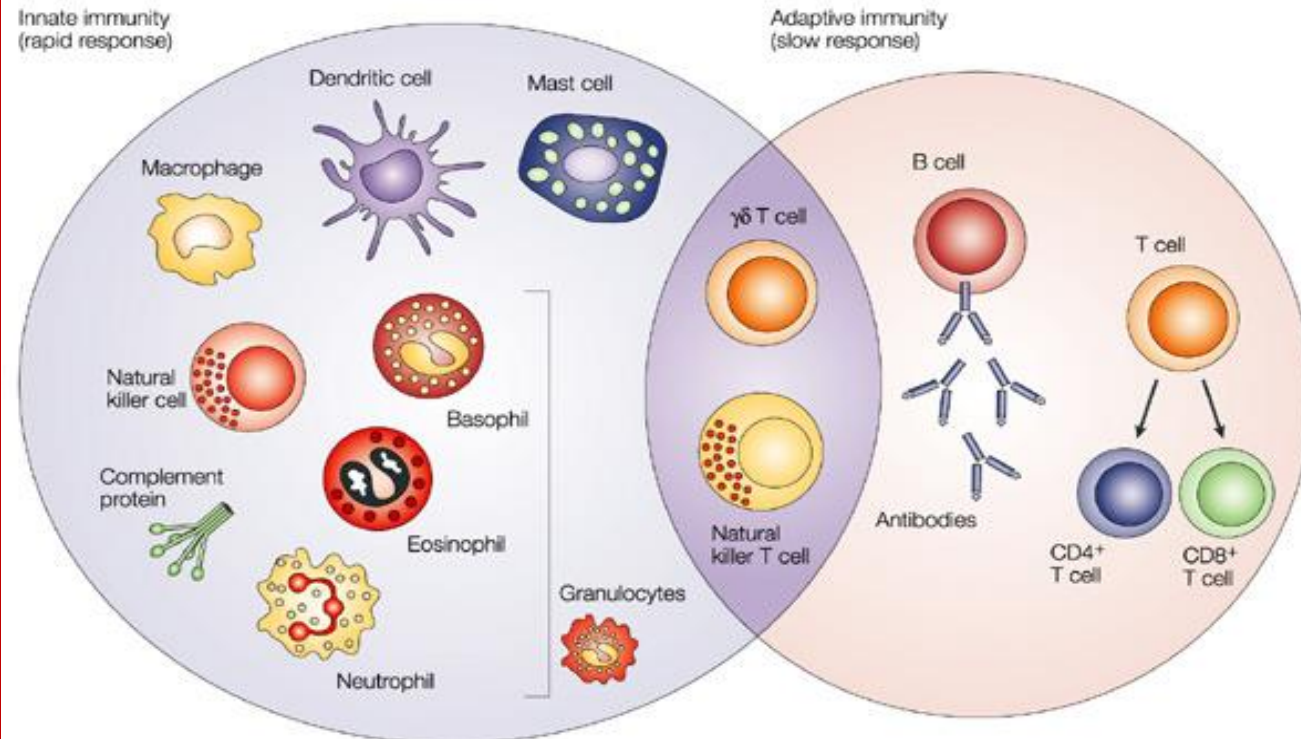
## ➤ Immune System

system of biological structure and processes to protect against diseases

# THE DIFFERENT TYPES OF IMMUNITY

INNATE IMMUNITY

ADAPTIVE IMMUNITY



## 1. Innate (non-adaptive)

- ▣ - first line of immune response
- ▣ - relies on mechanisms that exist before infection

## 2. Acquired (adaptive)

- ▣ - Second line of response (if innate fails)
- ▣ - relies on mechanisms that adapt after infection
- ▣ - handled by T- and B- lymphocytes
- ▣ - one cell determines one antigenic determinant

# THE INNATE IMMUNITY

## SURFACE BARRIERS:-

- Mucus, skin, gill, gut

## NONSPECIFIC HUMORAL FACTORS:-

- Growth inhibitors - Transferrin, Interferon
- Enzyme inhibitors -  $\alpha$ -2-macroglobulin
- Lysins - complement, AMPs, lysozyme
- Precipitins & agglutinins - pentraxins, lectins

## NONSPECIFIC CELLULAR FACTORS :-

- ▣ Phagocytes - Neutrophils  
- Macrophages
- ▣ Cytokines
- ▣ Natural Cytotoxic Cells
- ▣ Eosinophils, Basophils and Mast Cells

# Phagocytes and Their Relatives



Monocyte



Macrophage

Illustration by American Society of Hematology



Dendritic cell



Eosinophil



Mast cell



Neutrophil



Basophil

# Macrophages/ Monocytes

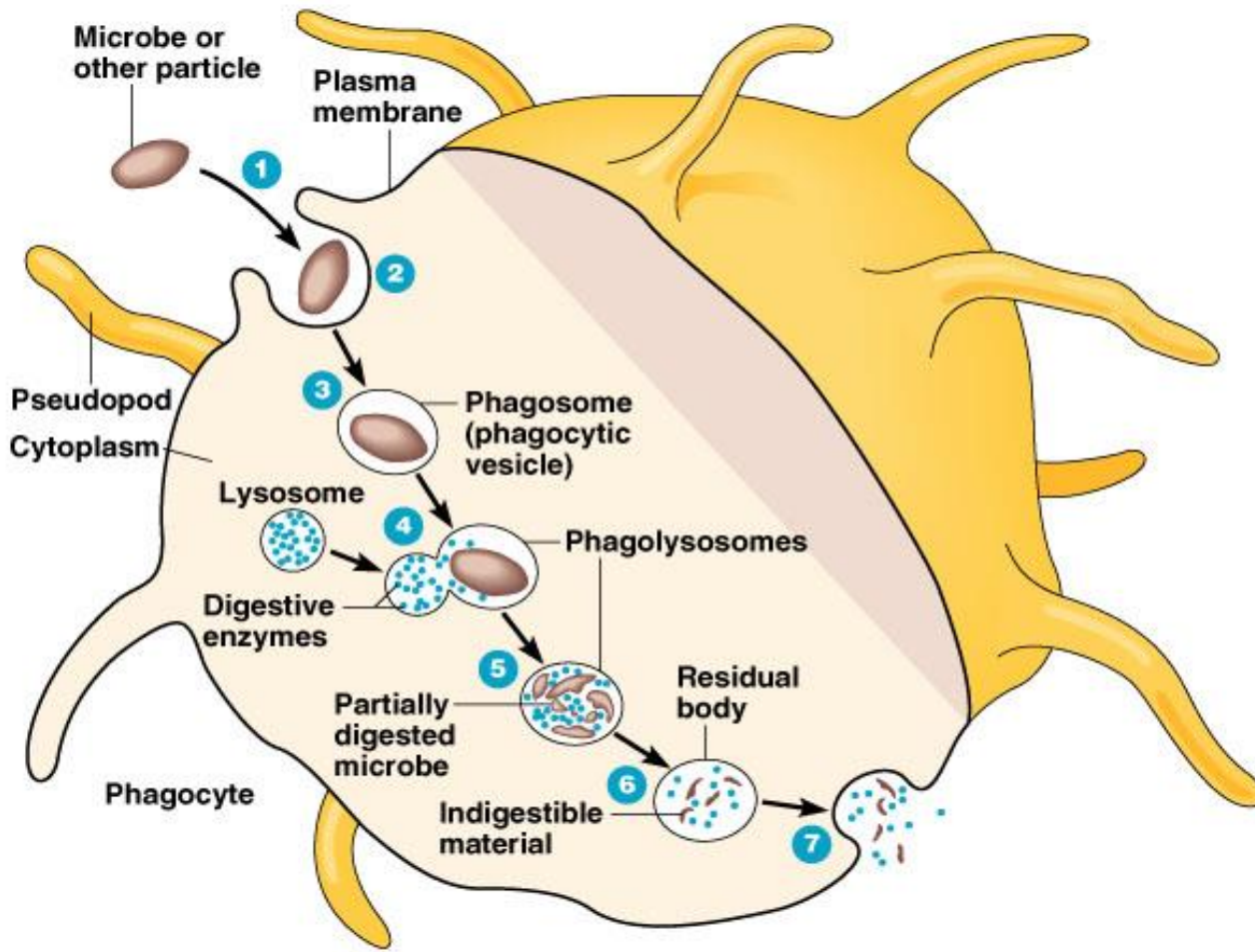
- ▣ Macrophages in teleost widespread in tissues including gills and the body cavity mainly found as reticulo-endothelial cells in the kidney and spleen and in some species, in the atrium of the heart.
- ▣ Monocytes are found in the kidney and in small numbers in the blood.
- ▣ Monocytes are considered as precursors of tissue macrophages.
- ▣ Functions:-  
phagocytosis, chemotaxis, bactericidal activity



# Neutrophils

- ▣ Present in kidney, spleen and blood in inflammatory lesions.
- ▣ Polymorphonuclear Cells
- ▣ Granules contain peroxidases, acid, alkaline phosphatases and defensins
- ▣ Receptors for both antibody (Fc) and complement components
- ▣ First to arrive at site of inflammation (leukocytosis)
- ▣ Functions:-  
phagocytic, chemotactic, bactericidal

# Phagocytosis



- 1 Chemotaxis and adherence of microbe to phagocyte.
- 2 Ingestion of microbe by phagocyte.
- 3 Formation of a phagosome.
- 4 Fusion of the phagosome with a lysosome to form a phagolysosome.
- 5 Digestion of ingested microbe by enzymes.
- 6 Formation of residual body containing indigestible material.
- 7 Discharge of waste materials.

**(a) Phases of phagocytosis**

# CYTOKINES

- ▣ Cytokines are low molecular weight regulatory proteins or glycoproteins secreted by white blood cells and various other cells in the body in response to a number of stimuli.
- ▣ Many act on phagocytes to attract them to a site of inflammation as seen with chemokines
- ▣ Involved in intercellular signalling.

# Natural Cytotoxic Cells

- ▣ Important in protection against viral, parasitic and neoplastic diseases
- ▣ They immobilize and kill the pathogen
- ▣ Have receptors for Fc region (ADCC)
- ▣ Main function is to kill self cells infected with viruses and some tumor cells
- ▣ 5 - 10 % of lymphocytes

# Eosinophils, Basophils and Mast Cells

- ▣ Eosinophils: Granular leukocytes (low in circulation)
- ▣ Attack parasites too large to be phagocytosed and kill them
- ▣ Basophils/ Mast Cells: Both have similar morphology
- ▣ Basophils found in circulation while mast cells in connective tissues
- ▣ Upon activation degranulate releasing pharmacological mediators causing vasodilation and attracting various cell types to the site
- ▣ E.g. Histamine, Cytokines

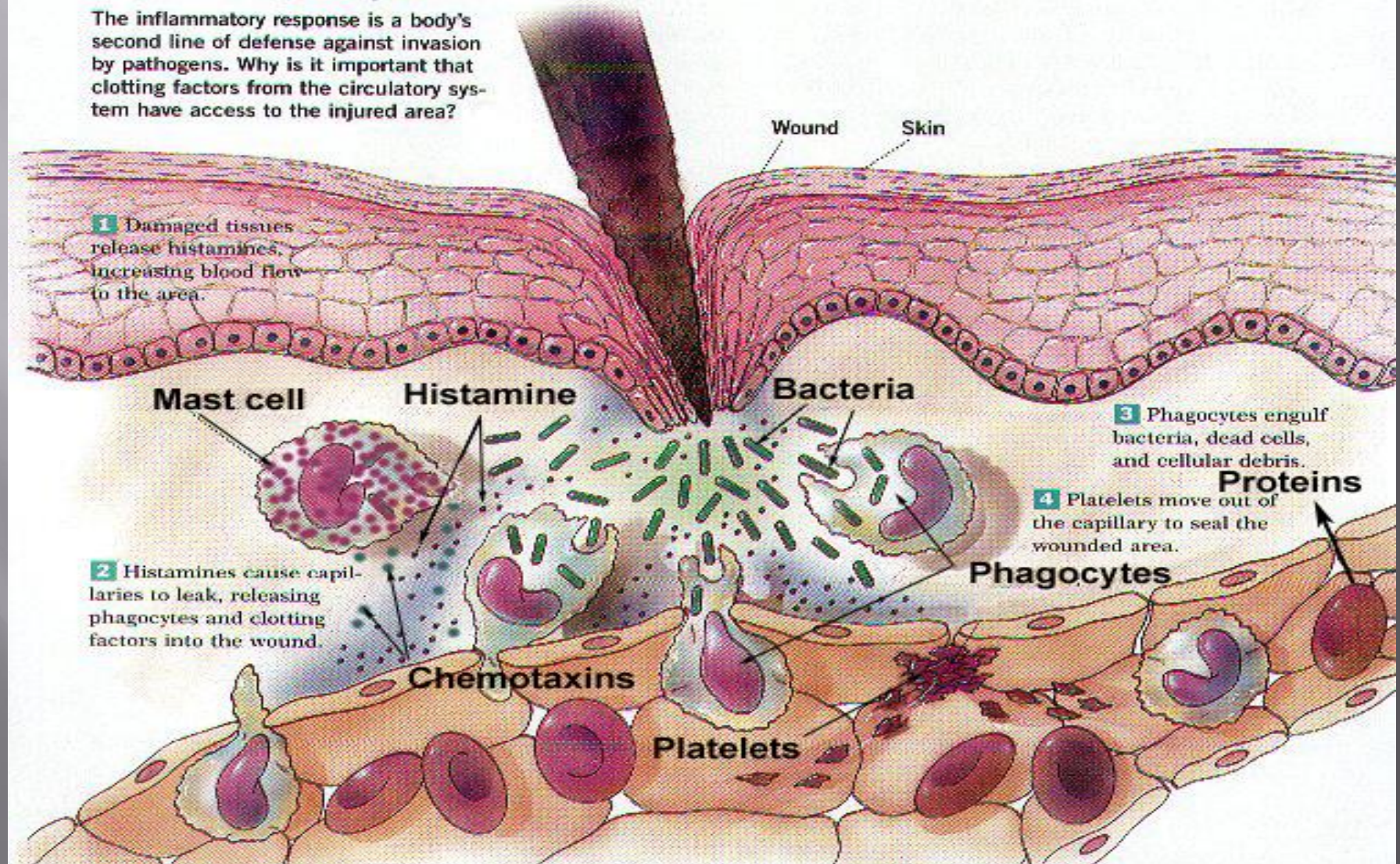
# INFLAMMATION

- ▣ Inflammation is the reaction of living tissue to injury caused due to presence of any forms of irritants.
- ▣ Protective response.
- ▣ 3 important events:-
  1. Increase vascularity of that area.
  2. Increase capillary permeability.
  3. Cellular migration.

# INFLAMMATORY RESPONSE

## Steps of the Inflammatory Response

The inflammatory response is a body's second line of defense against invasion by pathogens. Why is it important that clotting factors from the circulatory system have access to the injured area?



# COMPLEMENT SYSTEM

Complement is an enzyme cascade system present in serum and in tissue fluids.

Major humoral component of the innate immune response.

Fishes possess the complement system.

## FUNCTION

- Triggers inflammatory reaction

- Attract phagocytes by chemotaxis

- Clearance of immune complexes

- Cellular activation

- Direct microbial killing

- Role in the development of antibody response



# CONTINUE...

## ACTIVATION

- ❖ Classic pathway; initiated by formation of antigen-antibody complex
  - ❖ Alternative pathway; initiated by cell surface constituents that are foreign in origin
  - ❖ Lectin pathway; initiated by binding of MBL to mannose residue (present on glycoprotein-surface of microorganism)
- \* Activation of the complement system on a target cell surface, by way of these mechanisms leads to a common membrane attack complex results in disruption and lysis of the cell.

# THE ADAPTIVE IMMUNITY

3 aspects of adaptive immunity:-

1. Humoral immunity
2. Cell mediated immunity
3. Immunological memory

Adaptive immunity displays four characteristic attributes:

- ✿ Antigenic specificity
- ✿ Diversity
- ✿ Immunologic memory
- ✿ Self/non-self recognition

# CELLS AND ORGANS OF ADAPTIVE IMMUNE SYSTEM

## LYMPHOID ORGANS

### ➤ Primary

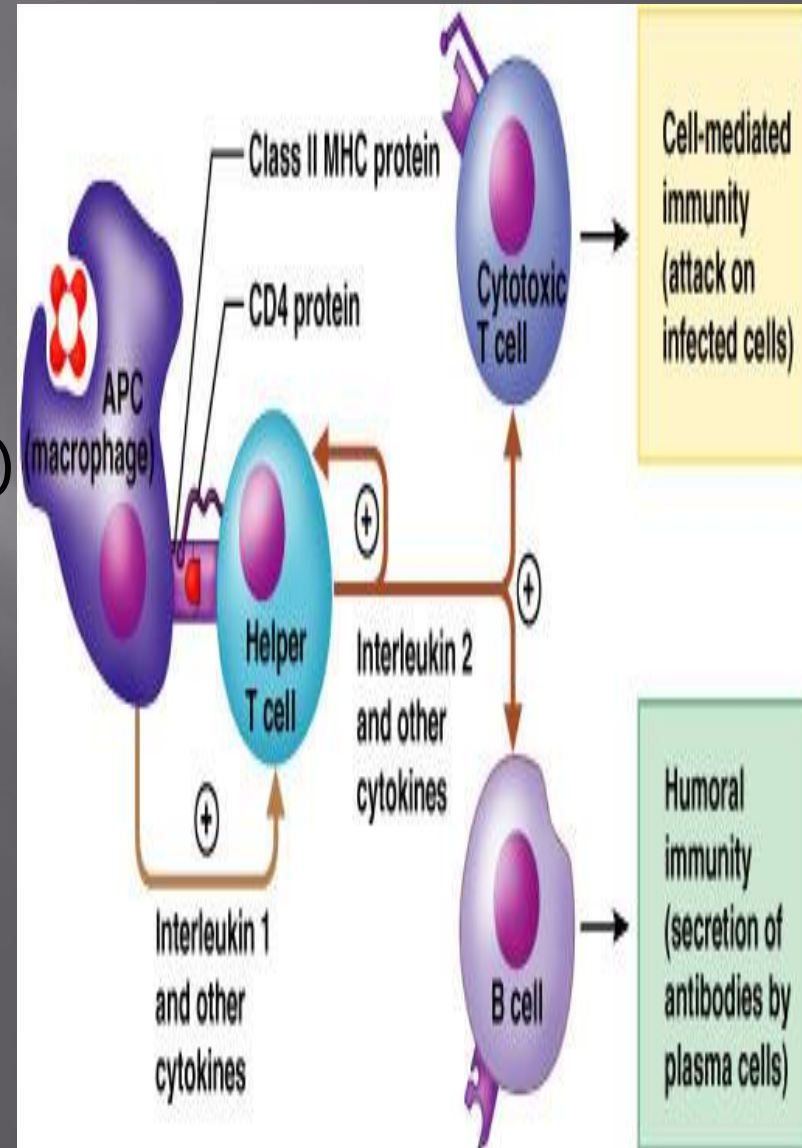
- i. Thymus
- ii. Kidney

### ➤ Secondary

- i. Encapsulated (Lymph node and Spleen)
- ii. Un-encapsulated (Mucosal associated lymphoid tissue, MALT)

## LYMPHOCYTES

- 20-40% of total leukocytes
- peripheral blood: 20-50%, remaining in lymphatic system
- two types of cells based on maturation site (B-cell and T-cell)



# LYMPHOCYTES

## T-lymphocytes

\*Key mediator in "Cell-mediated immunity."

### A. CTLs or Tc cells

Induce death of cells infected with virus  
Release perforin and granulysin-form pores in target cell's plasma membrane

### B. Helper T-cells

Not kills but directs other cells to perform this task

#### -T<sub>H1</sub> cells

Release interferon gamma-activates bactericidal activity

More effective against intracellular pathogen

#### -T<sub>H2</sub> cells

Release interleukin 4-activation of B-cells

More effective against extracellular pathogen, parasite, toxin

### C. Regulatory T-cells (Treg)

Limits and suppresses immune system

## T Cells

Resting helper T cell



Resting cytotoxic T cell



Artwork by Jeanne Kelly ©2004

Activated helper T cell



Activated killer cell

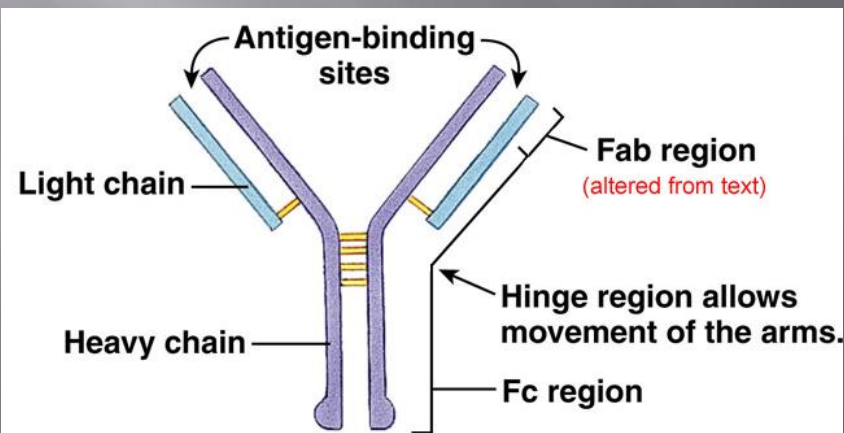


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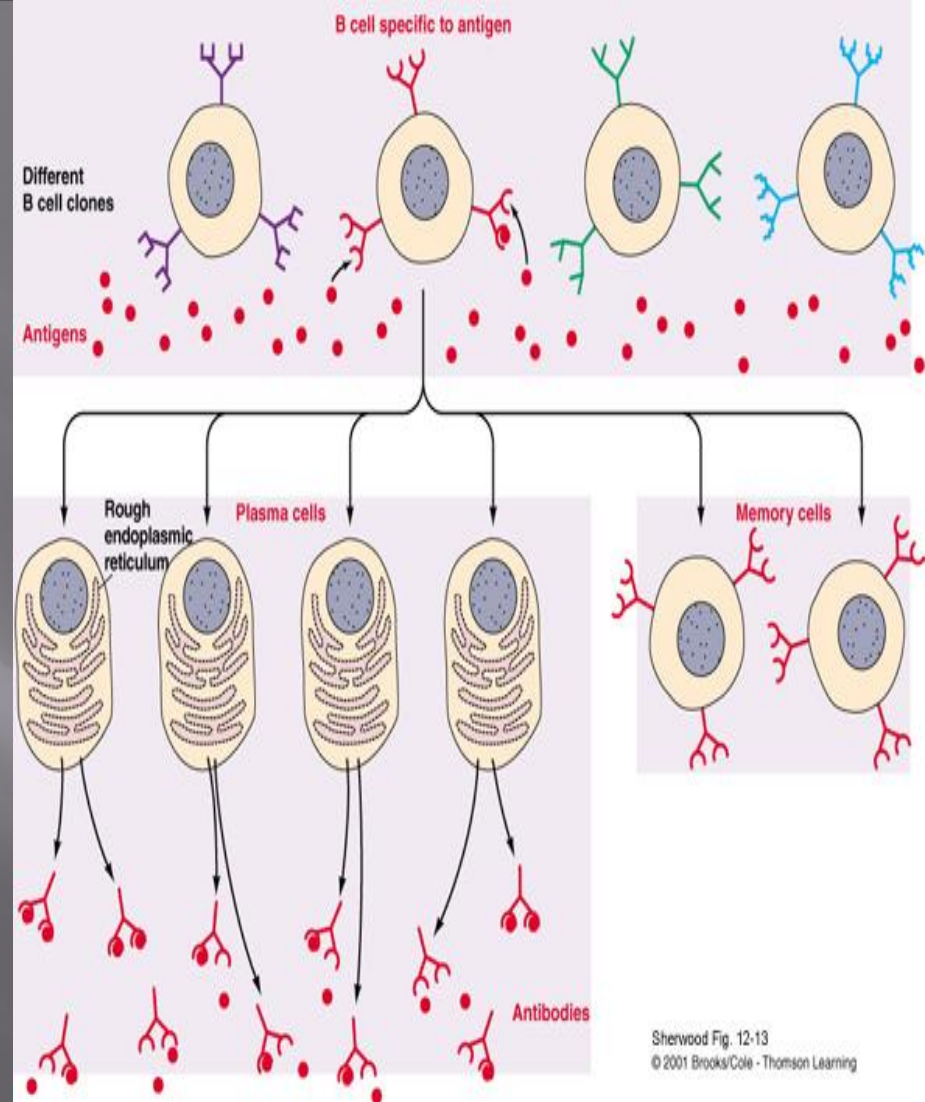
## B-lymphocytes

\*Key mediator in "Humoral immunity."

-Upon activation produce antibodies each of which recognizes unique antigen



An antibody molecule is composed of two identical light chains and two identical heavy chains, linked by disulfide bonds.



Sherwood Fig. 12-13  
© 2001 Brooks/Cole - Thomson Learning

## Antibodies

- Large Y shaped protein
- Identify and neutralize foreign substances

# CONTINUE...

## Memory cells

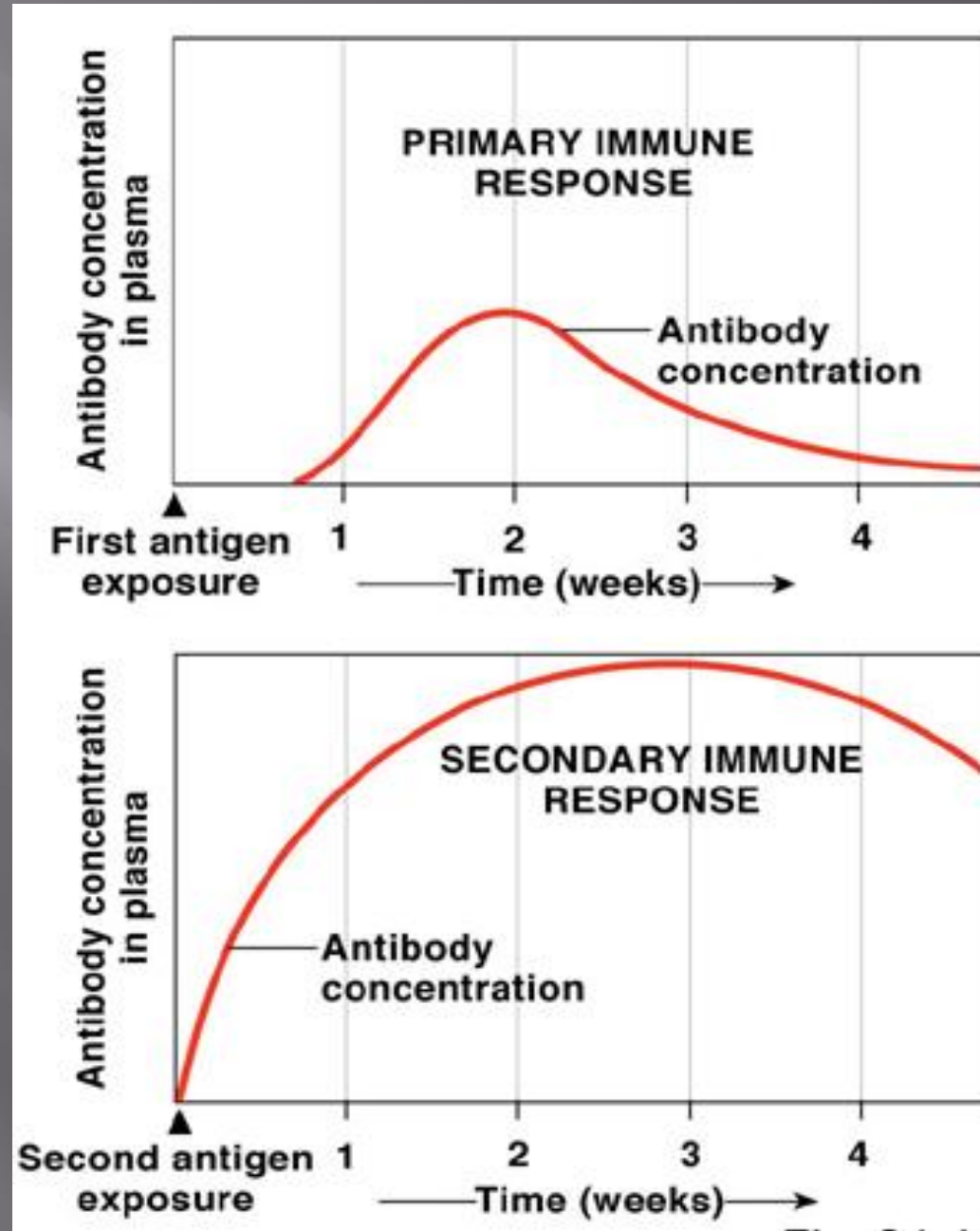
Some of the activated B and T-cells become memory cells-faster secondary response against the pathogen

## Passive Memory

-by injecting antibodies in the system

## Active Memory

-by natural or artificial exposure to the antigen or foreign molecule



## CONCLUDING REMARKS

The knowledge of immune system helps in understanding the nature's defense mechanism, which has been evolved and tested over time in its creations.

Study of fish immune system can provide us insight of the disease combating mechanism in fish which can further be used for producing disease resistant fishes or fishes with improved immunity.



Thank you!

