Immune Response and Cellular Immunity

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Objectives:

- Provide overview of Immune system and its components
- Outline how cell mediated immunity fits in overall immune response
- Cover some of the important vocabulary words that are part of the immune response

Lymphoid System Components

Primary Lymphoid Organs

Bone Marrow – source of progenitor stem cells
differentiation,
and maturation of
B Lymphocytes

Thymus – Maturation site of T Lymphocytes

Secondary Lymphoid Organs

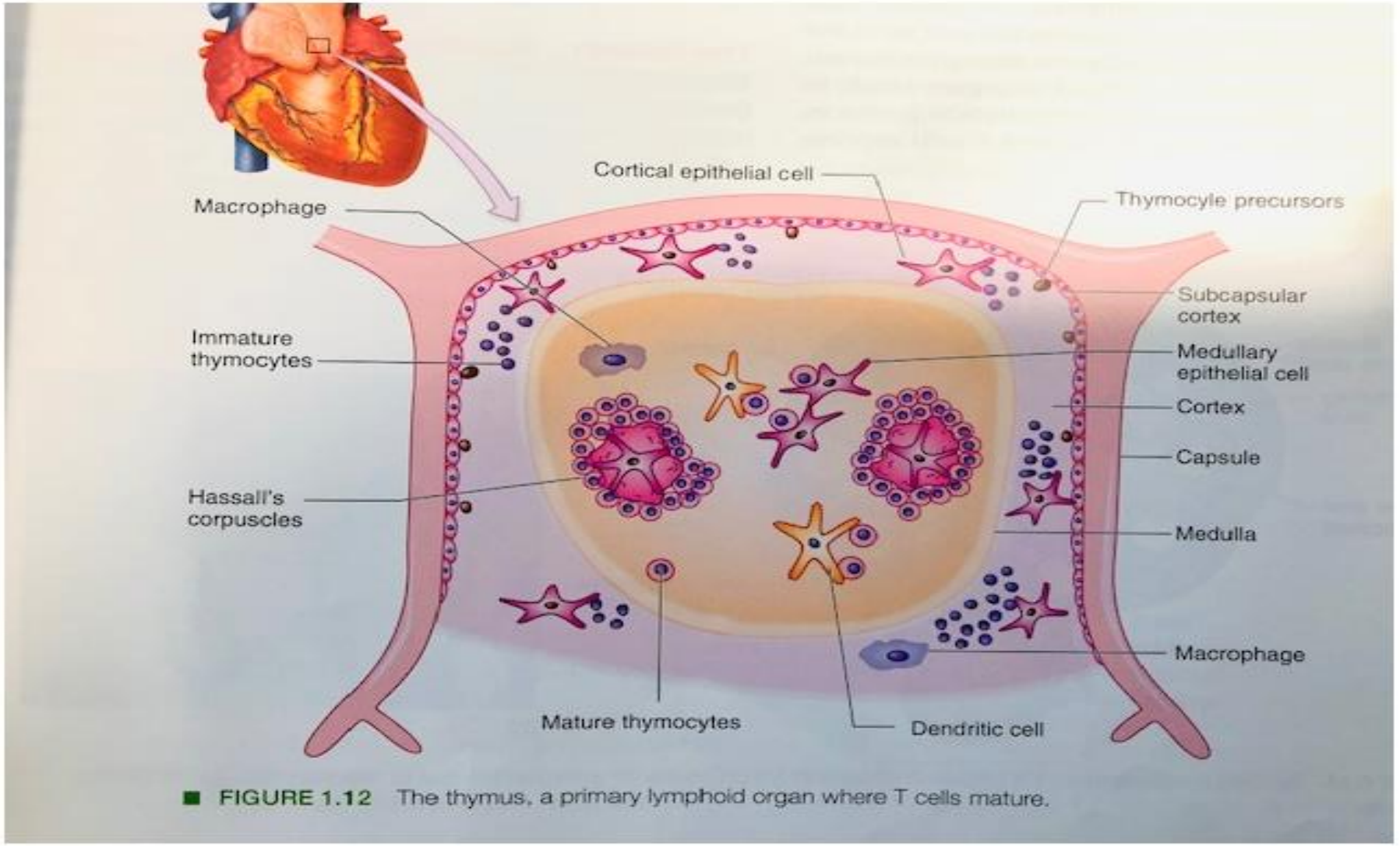
Lymph node

Spleen

MALT – mucosal- associated lymphoid tissue

CALT – cutaneous-associated lymphoid tissue

T cell Maturation



■ FIGURE 1.12 The thymus, a primary lymphoid organ where T cells mature.

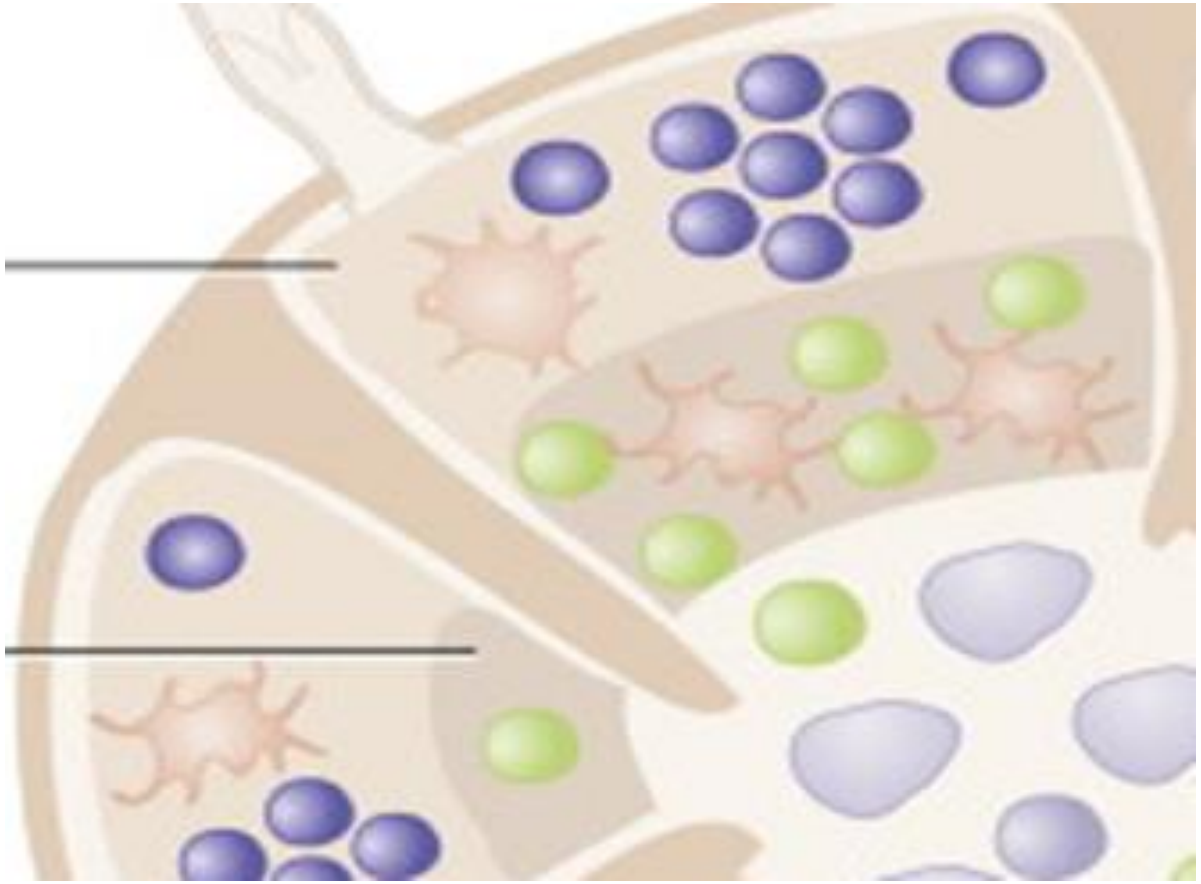
Class I - Phenotypic marker: CD3+CD4-CD8+ (CD8 - Cytotoxic T cells)

Class II - Phenotypic marker: CD3+CD4+CD8- (CD4 - Helper T cells)

Cross section of Lymph node

Cortex
B cell area
(primary follicles-naïve B cells)
(secondary follicles-germinal centers)

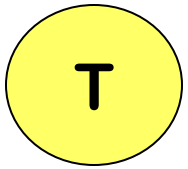
Paracortex
T cell area



Cells of the Immune System

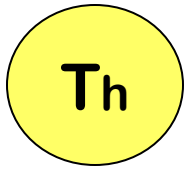
Innate or Natural

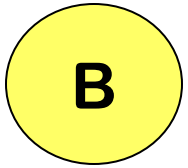
Acquired



T-Cell

Helper
T-cell

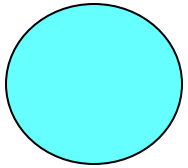




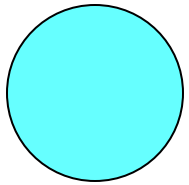
B-cell

Granulocytes,
Larger than B
& T cells,
DO NOT have
unique surface
antigens from
T and B cells

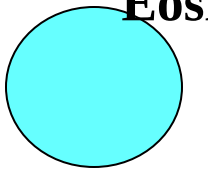
Macrophage

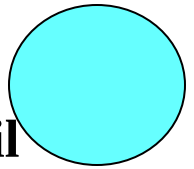


Neutrophil



Eosinophil





Basophil

Overview of the Immune System

Innate immunity

- **"Natural" immunity**
  - Does not "recognize" specific antigens
  - Response does not improve with repeated infections
- **Examples include:**
  - Anatomical barriers (ie, skin, mucous membranes)
  - Non-specific proteins (ie, complement)
  - Non-specific cells (ie, NK cells)

Adaptive immunity

- Specificity and memory
  - Cells recognize specific infectious agents
  - Initial exposure leads to increased response if reinfected

Humoral

- B cells - antibodies

Cell-mediated

- **T cells**

Both systems work together in a regulated fashion during an immune response

Acute Phase Reactants

- C-reactive protein (CRP)- phagocytosis, opsonization, agglutination, precipitation and activation of complement.
- Serum amyloid A- Activates monocytes and macrophages
- Complement- opsonization and lysis of cells
- ά$_1$-Antitrypsin- regulates proinflammatory cytokines
- Haptoglobin - Antioxidant activity
- Fibrinogen - promotes clot formation

Cells of the Innate Immune System

Natural Internal Defense Mechanism

- Neutrophils – One of the first cell types recruited to acute injury or inflammation site**.**

  phagocytic **granulocyte**, attracted by chemotactic factors like cytokines
- Basophils – Not phagocytic **granulocytes**, (granules- histamine, heparin & eosinophil chemotactic factor)
- Eosinophils – **Granulocytes** with role in allergic reaction and parasitic infection. Capable of phagocytosis but lack digestive enzymes.
- Monocytes – Mononuclear phagocytic **agranulocytes,** largest cell in peripheral blood, once in tissues undergo differentiation and cell division and become macrophages. Function in surveillance and destruction of microbes, viruses and tumors.
- Macrophages and neutrophils – Most active phagocytes

Phagocytosis

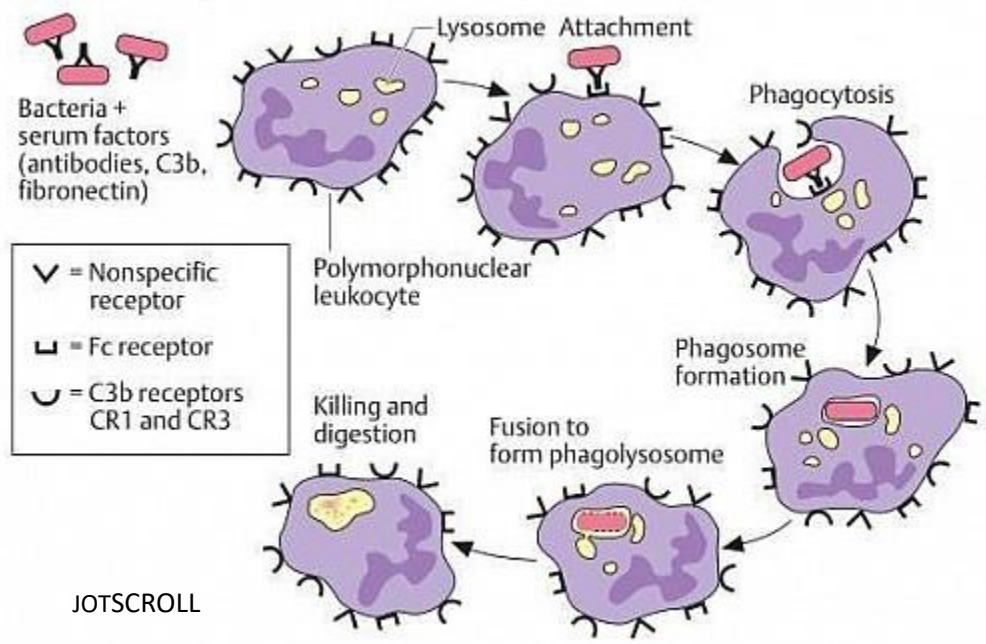
1. Chemotaxis – Unidirectional migration of cells in response to chemotactic factors (e.g., chemokines)

2. Opsonization – Coating of the organisms by molecules that speed up phagocytosis
   IgG and C3b

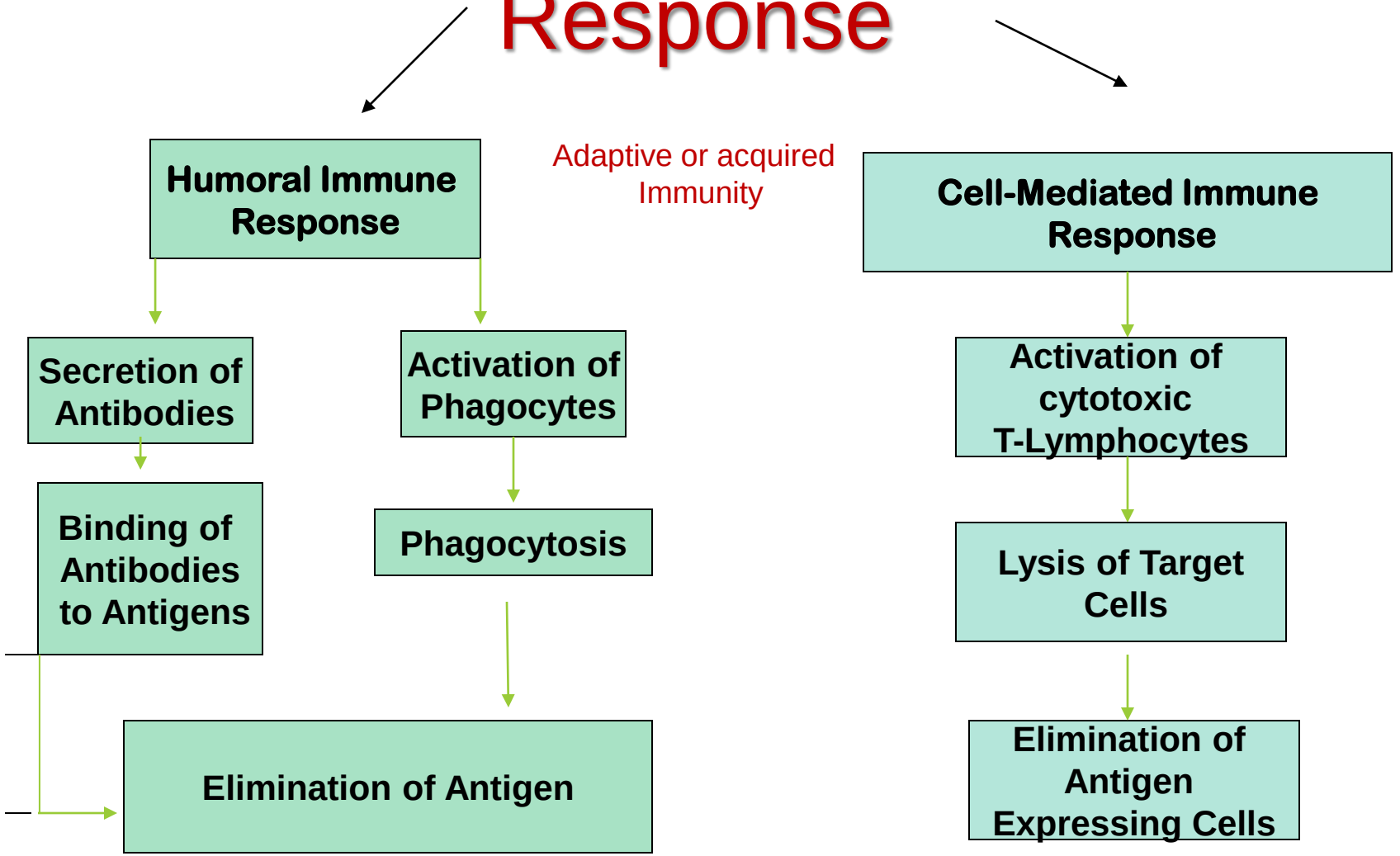
3. Adherence – Attachment of leukocyte (macrophage or neutrophil) to the organism

4. Engulfment – Phagosome formation

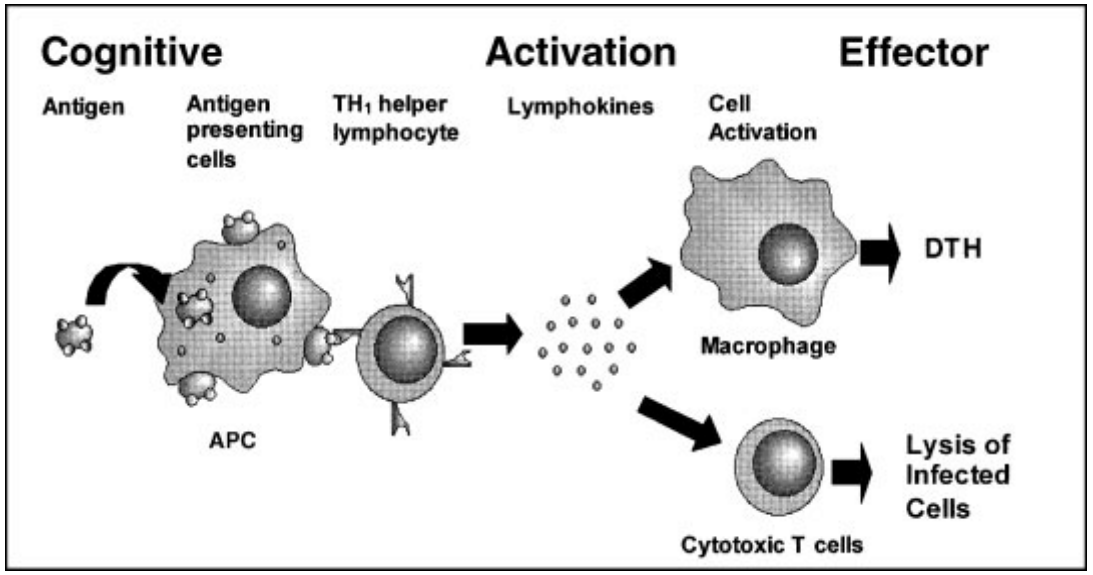
3. Digestion and destruction - Phagolysosome



Specific Immune Response



Cell Mediated Immunity



These responses are especially important for destroying **intracellular bacteria**, eliminating **viral infections** and destroying **tumor cells**

Types of Immunity

- Innate (Natural)- It involves barriers you were born with that form first line of defense in the non-specific immune response. It is composed of external and internal defense system.

- Adaptive (Acquired)- A specific immunity that develops when a person's immune system responds to a foreign substance and builds a memory (active) or when person receives antibodies from another source (passive)

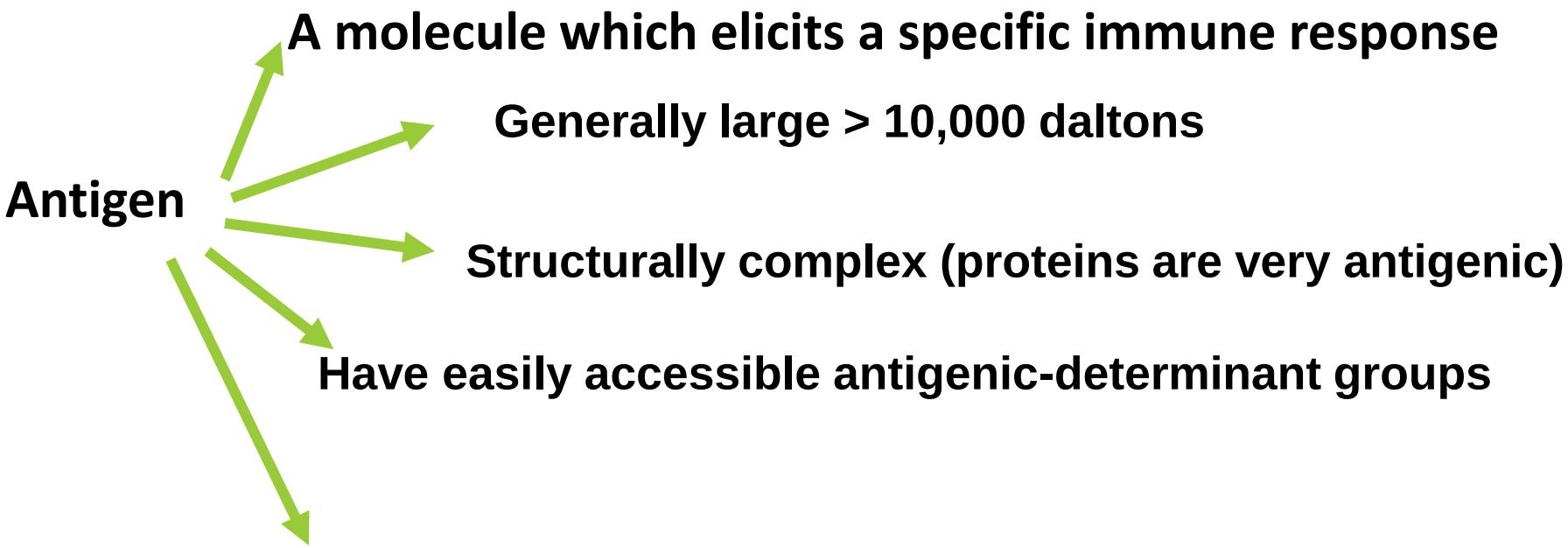
Active	VS	Passive
The immunity is longer lived		Antibody is available more quickly

Antigen

Antigen : a substance that can bind to an antibody or sensitized cells - but may or may not induce an immune response

* ***N*ot all antigens are immunogens, but all immunogens are considered antigens**.

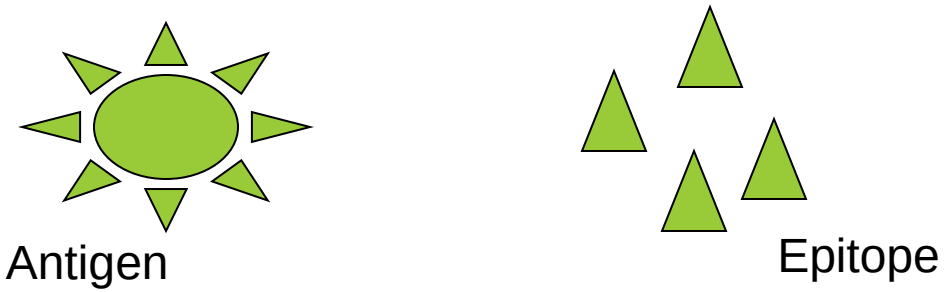
Antigen or Immunogen



Epitope (antigenic determinant)

Smallest active site on an antigen that is capable of binding -

- with a specific complementary antibody.
- with a surface immunoglobulin antibody on a B cell.
- When recognized by T cells as foreign, it can trigger an immune response.



Haptens

- Antigenic determinants that are too small to be recognized alone → but if these substances are "complexed" with a larger molecule **~>** they become immunogenic.
- **Hapten +carrier ~> immunogenic**

- ***Ex*** : the chemical catechols (poison ivy) are haptens → once in contact with skin, they combine with tissue proteins **~>** immunogens that causes contact dermatitis !

Adjuvent

- A substance when added to an Immunogen, can increase the level of immune response.

Example: **Freund's complete adjuvent** – which combines mineral oil emulsifier and killed Mycobacteria→ it helps to prolong the immune stimulation, thus result in a higher immune response.

Auto & Allo Antigens

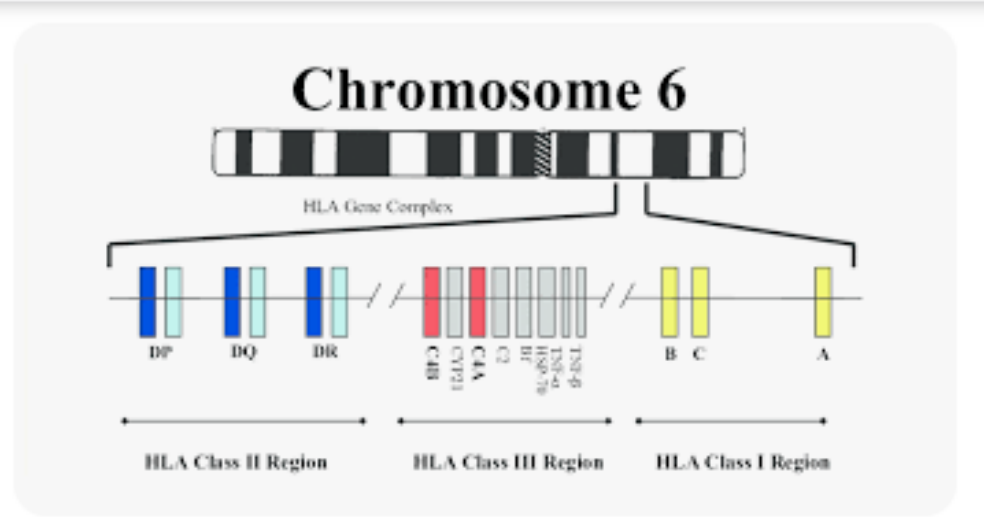
Classify the antigens according to their relationship to the host:

- Autoantigens- antigens that belong to the host him/herself.
- Alloantigens: antigens from other members of the host species. Example: ABO blood group and HLA
- Heteroantigens: from other species.

Human Leukocyte Antigen (HLA)

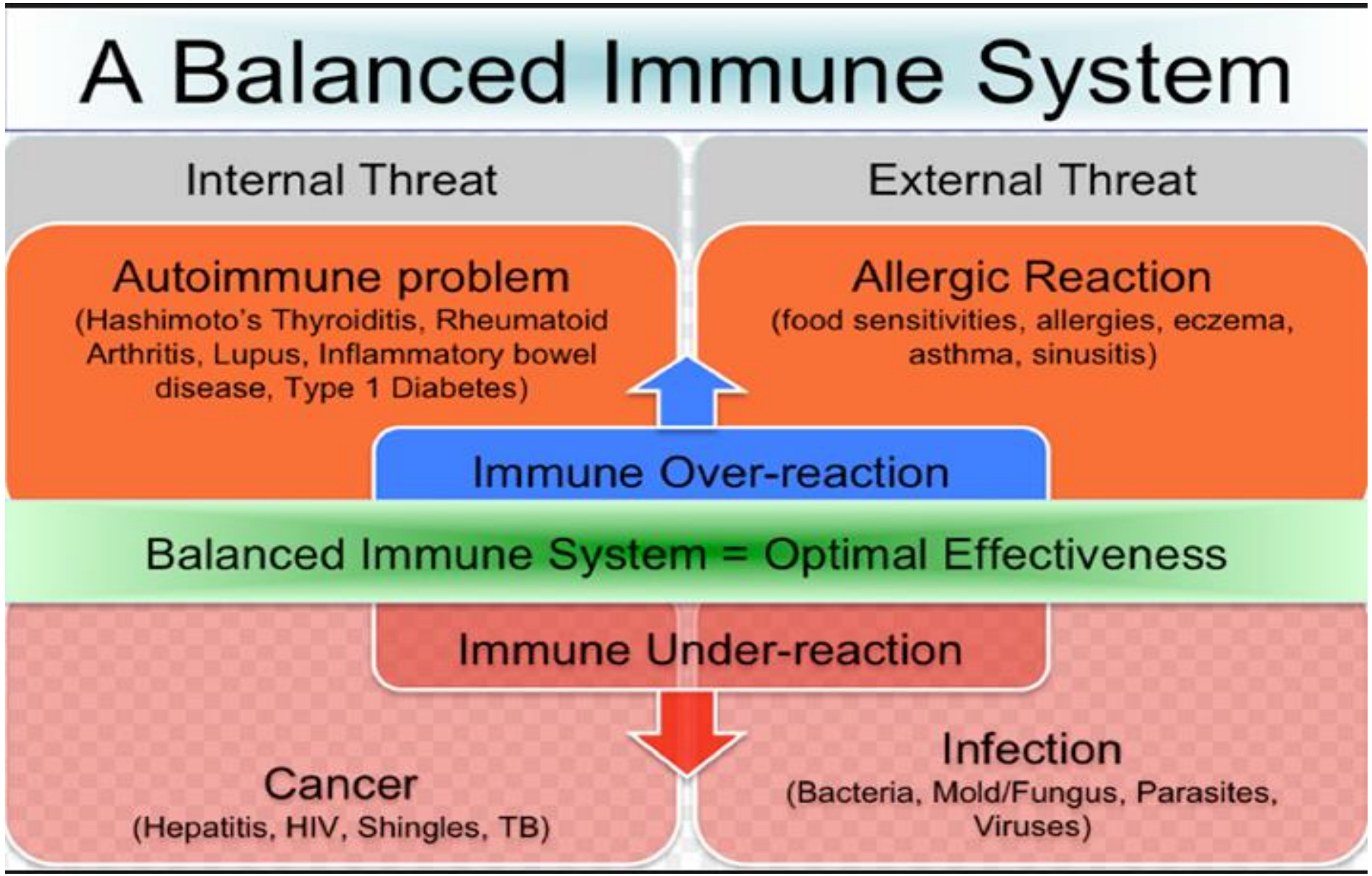
- 2 classes MHC I and MHC II

- MHC I – (loci A, B & C) genes encoding molecules that present antigen to $CD8^{+}$ T cells
- MHC II –(loci D) genes encoding molecules that present antigen to $CD4^{+}$ cells
- MHC III – genes encoding complement and cytokine molecules. Not expressed on cell surfaces.



ResearchGate

HLA region on human chromosome 6 ...


A Balanced Immune System
Internal Threat
External Threat
Autoimmune problem
(Hashimoto's Thyroiditis, Rheumatoid Arthritis, Lupus, Inflammatory bowel disease, Type 1 Diabetes)
Allergic Reaction
(food sensitivities, allergies, eczema, asthma, sinusitis)
Immune Over-reaction
Balanced Immune System = Optimal Effectiveness
Immune Under-reaction
Cancer
(Hepatitis, HIV, Shingles, TB)
Infection
(Bacteria, Mold/Fungus, Parasites, Viruses)