

**A.S.D.GOVERNMENT DEGREE COLLEGE FOR  
WOMEN (AUTONOMOUS) KAKINADA**

**DEPARTMENT OF MICROBIOLOGY**

# *Hypersensitivity Reactions*

**II BSc CBMB SEM IV**

**BY**

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# Hypersensitivity reactions

**Hypersensitivity reactions (HR)** are immune responses that are exaggerated or inappropriate against an antigen or allergen.

Coombs and Gell classified **hypersensitivity reactions** into four forms

## **Type I: Immediate Hypersensitivity (Anaphylactic Reaction)**

These allergic reactions are systemic or localized, as in allergic dermatitis (e.g., hives and erythematic reactions)

## **Type II: Cytotoxic Reaction (Antibody-dependent)**

## **Type III: Immune Complex Reaction**

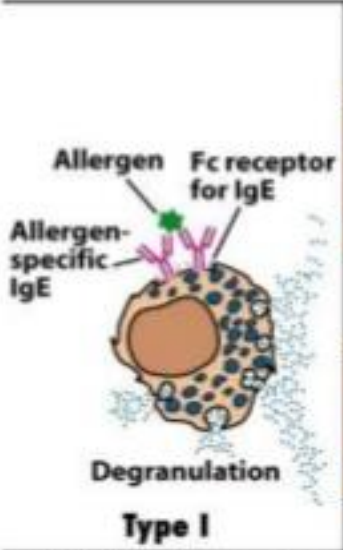
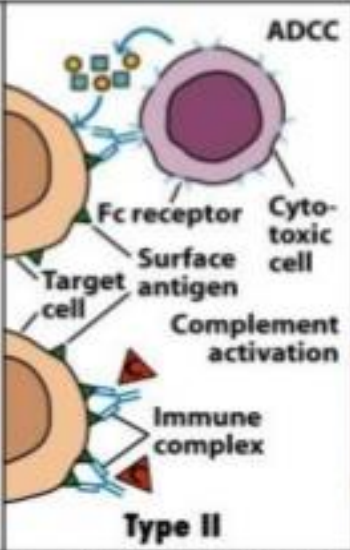
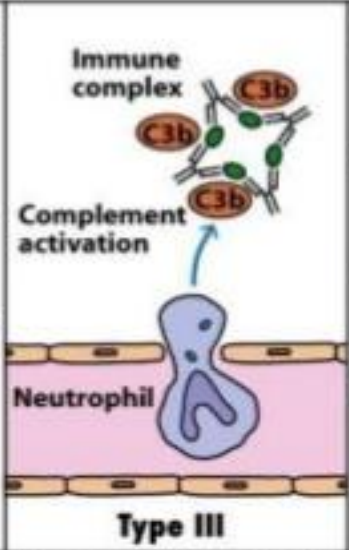
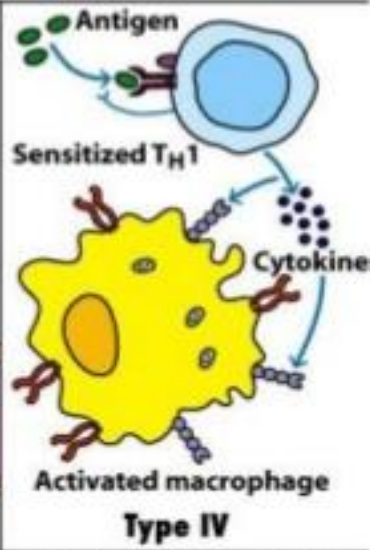
## **Type IV: Cell-Mediated (Delayed Hypersensitivity)**

# Hypersensitivity reactions

Hypersensitivity reactions			
	Humoral components	Cellular components	Examples
Type I (immediate)	<ul style="list-style-type: none"> <li>IgE</li> </ul>	<ul style="list-style-type: none"> <li>Basophils</li> <li>Mast cells</li> </ul>	<ul style="list-style-type: none"> <li>Anaphylaxis</li> <li>Allergies</li> </ul>
Type II (cytotoxic)	<ul style="list-style-type: none"> <li>IgG &amp; IgM autoantibodies</li> <li>Complement activation</li> </ul>	<ul style="list-style-type: none"> <li>NK cells</li> <li>Eosinophils</li> <li>Neutrophils</li> <li>Macrophages</li> </ul>	<ul style="list-style-type: none"> <li>Autoimmune hemolytic anemia</li> <li>Goodpasture syndrome</li> </ul>
Type III (immune complex)	<ul style="list-style-type: none"> <li>Deposition of antibody-antigen complexes</li> <li>Complement activation</li> </ul>	<ul style="list-style-type: none"> <li>Neutrophils</li> </ul>	<ul style="list-style-type: none"> <li>Serum sickness</li> <li>PSGN</li> <li>Lupus nephritis</li> </ul>
Type IV (delayed type)	<ul style="list-style-type: none"> <li>None</li> </ul>	<ul style="list-style-type: none"> <li>T cells</li> <li>Macrophages</li> </ul>	<ul style="list-style-type: none"> <li>Contact dermatitis</li> <li>Tuberculin skin test</li> </ul>

NK = natural killer; PSGN = poststreptococcal glomerulonephritis.

# Hypersensitivity reactions

 <p><b>Type I</b></p>	 <p><b>Type II</b></p>	 <p><b>Type III</b></p>	 <p><b>Type IV</b></p>
<p>IgE-Mediated Hypersensitivity</p>	<p>IgG- or IgM-Mediated Cytotoxic Hypersensitivity</p>	<p>Immune Complex-Mediated Hypersensitivity</p>	<p>Cell-Mediated Hypersensitivity</p>
<p>Ag induces cross-linking of IgE bound to mast cells and basophils with release of vasoactive mediators.</p>	<p>Ab directed against cell surface antigens mediates cell destruction via complement activation or ADCC.</p>	<p>Ag-Ab complexes deposited in various tissues induce complement activation and an ensuing inflammatory response mediated by massive infiltration of neutrophils.</p>	<p>Sensitized TH1 cells shown above release cytokines that activate macrophages or TC cells that mediate direct cellular damage. TH2 cells and CTLs mediate similar responses.</p>
<p>Typical manifestations include systemic anaphylaxis and localized anaphylaxis such as hay fever, asthma, hives, food allergies, and eczema.</p>	<p>Typical manifestations include blood transfusion reactions, erythroblastosis fetalis, and autoimmune hemolytic anemia.</p>	<p>Typical manifestations include localized Arthus reaction and generalized reactions such as serum sickness, necrotizing vasculitis, glomerulonephritis, rheumatoid arthritis, and systemic lupus erythematosus.</p>	<p>Typical manifestations include contact dermatitis, tubercular lesions, and graft rejection.</p>

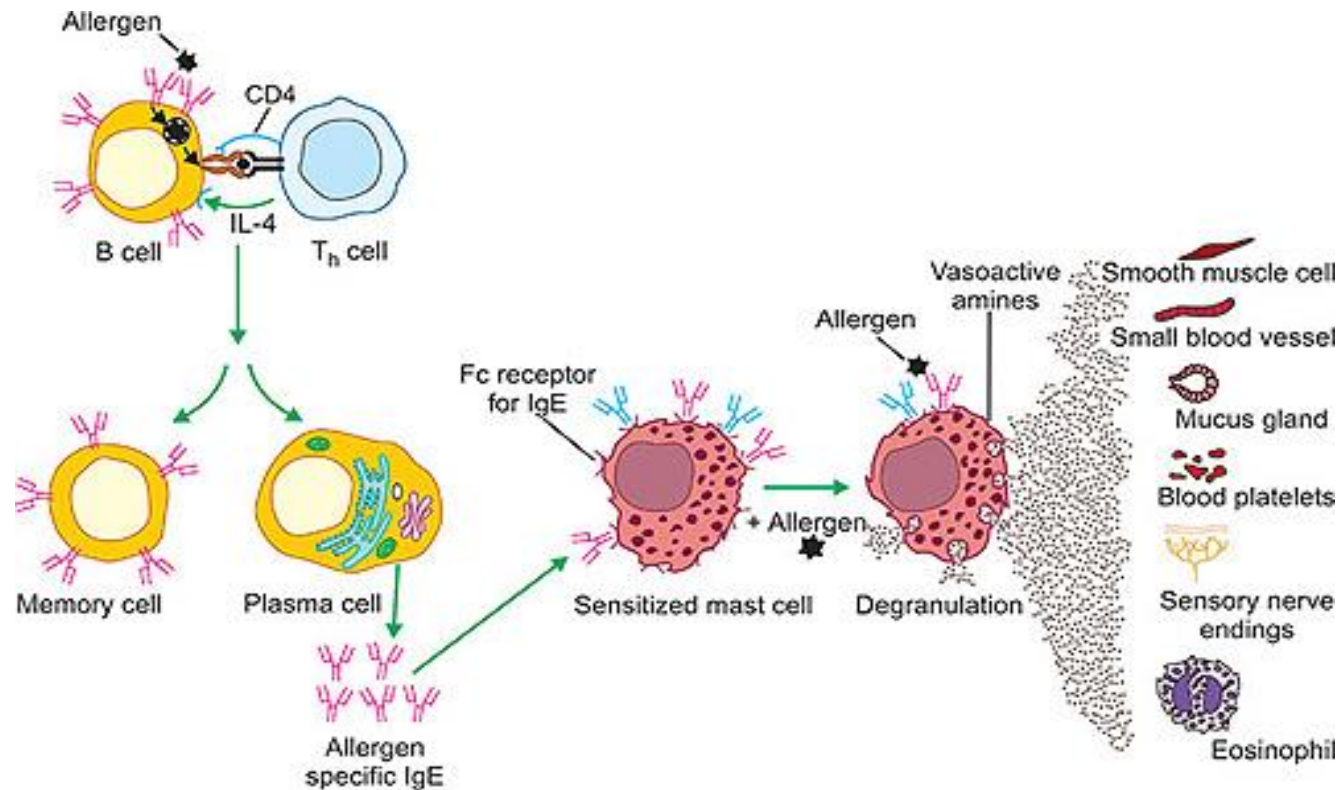
# **Type I: Immediate Hypersensitivity (Anaphylactic Reaction)**

Anaphylactic Response is mediated by IgE antibodies that are produced by the immune system in response to environmental proteins (allergens) such as pollens, animal danders or dust mites.

These antibodies (IgE) bind to mast cells and basophils, which contain histamine granules that are released in the reaction and cause inflammation.

Type I hypersensitivity reactions can be seen in bronchial asthma, allergic rhinitis, allergic dermatitis, food allergy, allergic conjunctivitis, and anaphylactic shock.

# Type I: Immediate Hypersensitivity



## Ig E - Mediated Hypersensitivity Reaction

# Type I: Immediate Hypersensitivity (Anaphylactic Reaction)

**Anaphylaxis:** Due to suddenly release a large amount of histamine and later on leukotrienes. In severe cases intense bronchospasm, laryngeal edema, cyanosis, hypotension, and shock are present.

**Allergic rhinitis:** Allergic rhinitis is another atopic disease where histamine and leukotrienes are responsible for rhinorrhea, sneezing and nasal obstruction.

**Allergic conjunctivitis:** Allergic conjunctivitis presents with rhinitis and is IgE-mediated. Itching and eye problems including watering, redness, and swelling always occur.

**Food allergy:** One must differentiate food allergy (IgE-mediated) from food intolerance that can be cause for a variety of etiology including malabsorption and celiac disease.

**Atopic eczema:** It is an IgE-mediated disease that affects the skin.

**Drug allergy:** Drugs may cause allergic reactions by any mechanism of hypersensitivity. For example penicillin may cause anaphylaxis.

# Type II: Cytotoxic Reaction (Antibody-dependent)

IgG mediate cytotoxic-mediated response against cell surface and extracellular matrix proteins.

The immunoglobulins involved in this type of reaction damages cells by activating the complement system or by phagocytosis.

Type II hypersensitivity reactions can be seen in....

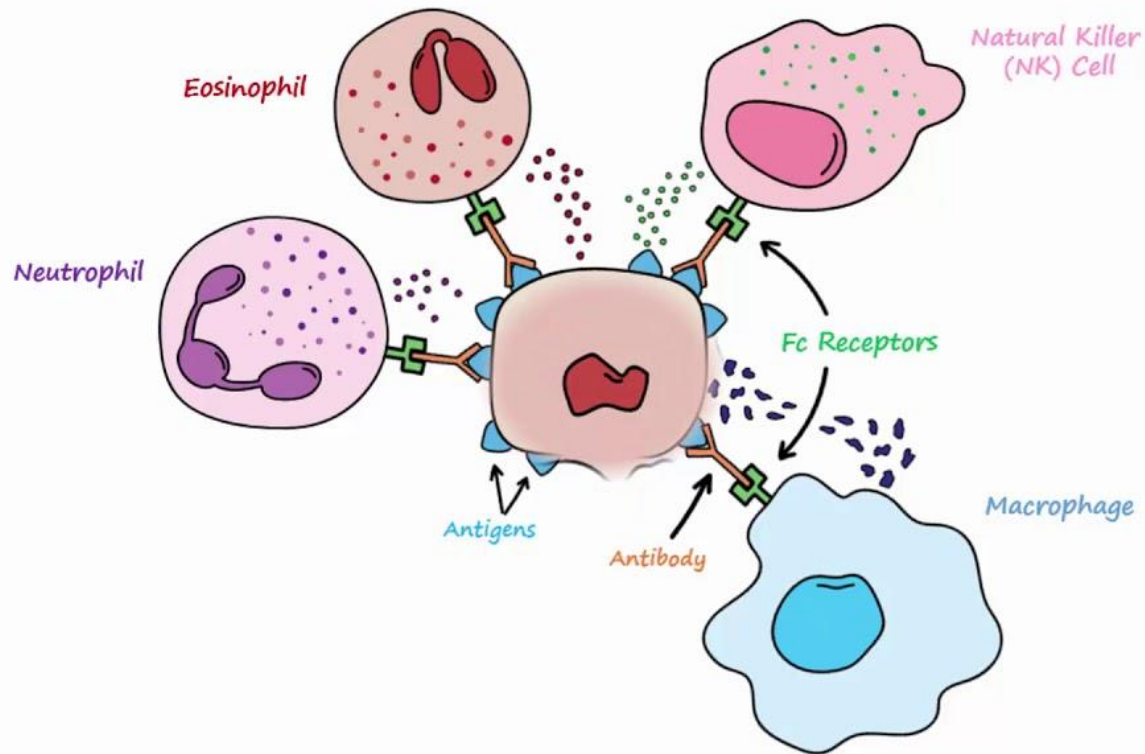
1. Immune thrombocytopenia
2. Autoimmune hemolytic anemia
3. Autoimmune neutropenia.
4. Hemolytic disease of the fetus and the newborn (erythroblastosis fetalis)

## Immune thrombocytopenia (ITP)

ITP is an autoimmune disorder that occurs at any age. Phagocytes destroy sensitized platelets in the peripheral blood. Clinically, it manifests by thrombocytopenia with shortened platelet survival .Sudden onset of petechiae and bleeding from the gums, nose, bowel, and urinary tract occurs.

# Type II: Cytotoxic Reaction (Antibody-dependent)

## 2. Antibody-Dependent Cell-Mediated Cytotoxicity (ADCC)



# Type III: Immune Complex Reaction

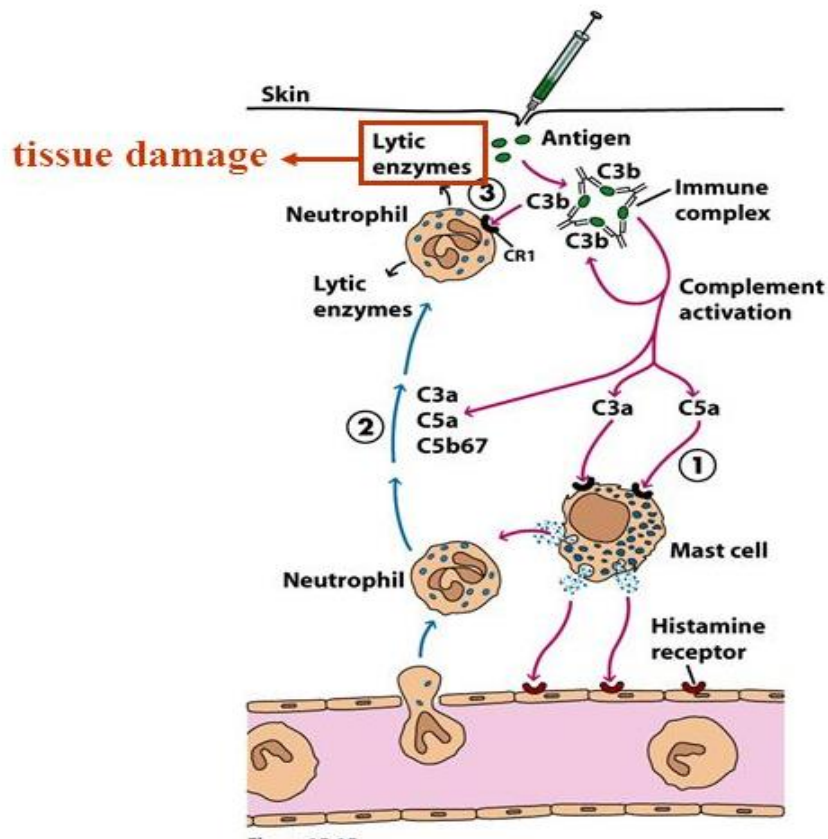
These are also mediated by IgM antibodies that react with **soluble antigens** forming antigen-antibody complexes.

The complement system becomes activated and releases chemotactic agents that attract neutrophils and cause inflammation and tissue damage as seen in vasculitis and **glomerulonephritis**.

Type III hypersensitivity reactions can classically be seen in **Serum sickness** and **Arthus reaction**.

# Type III hypersensitivity

## Localized Type III Reaction - Arthus Reaction



Type III hypersensitivity:  
Generalized reactions as serum sickness, Glomerul nephritis and systemic lupus erythematic

# Type IV hypersensitivity:

Nature of Antigen: Soluble Antigen

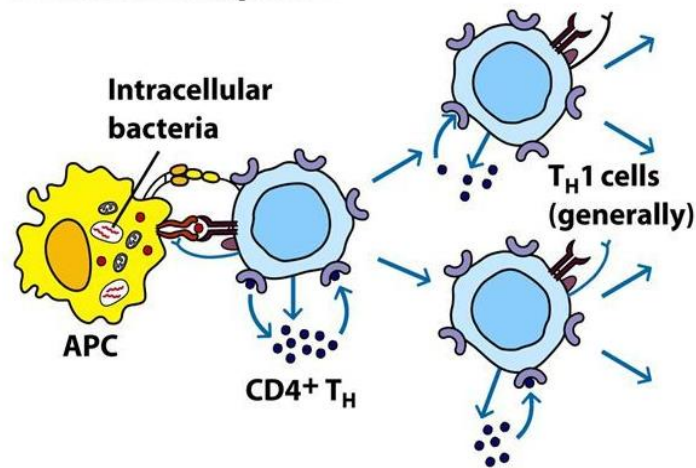
Type of Immunity : Cellular

Effector Molecules: Various cytokines secreted by  
activated Tc cells

Cellular damage

# Type IV: Cell-Mediated (Delayed Hypersensitivity)

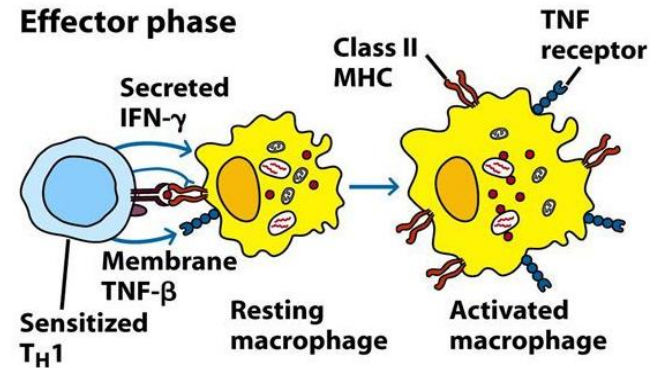
## Sensitization phase



Antigen-presenting cells: Macrophages  
Langerhans cells

DTH-mediating cells:  
T<sub>H</sub>1 cells generally  
CD8 cells occasionally

## Effector phase



T<sub>H</sub>1 secretions:  
Cytokines: IFN-γ, TNF-β, IL-2, IL-3, GM-CSF, MIF  
Chemokines: IL-8/CXCL8, MCP-1/CCL2

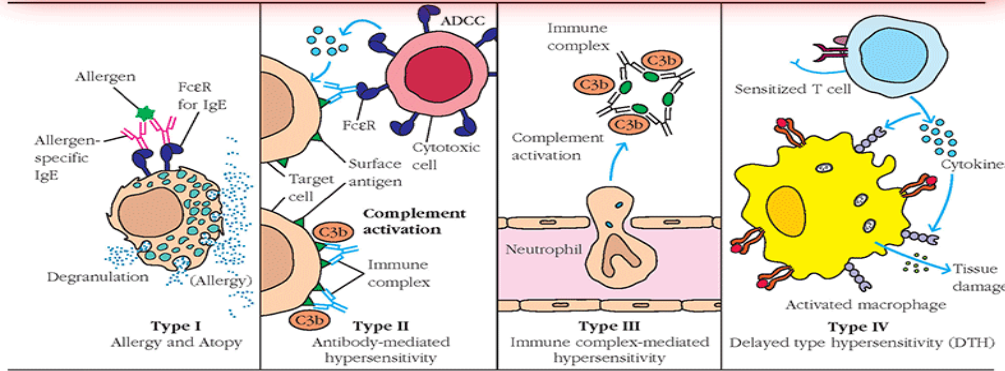
Effects of macrophage activation:  
↑ Class II MHC molecules  
↑ TNF receptors  
↑ Oxygen radicals  
↑ Nitric oxide

Type IV hypersensitivity is initiated by soluble antigens, which activates the T<sub>H</sub>1 cells, The activated T<sub>H</sub>1 cells release cytokines that activate Macrophages or T<sub>C</sub> cells which mediates the cellular damage.

Activated T<sub>C</sub> cell secrete various cytokines and act as effector molecule.

Eg: Contact dermatitis, Graft rejections and tubercular lesions.

## Type I vs Type II vs Type III vs Type IV



Thank you