


Understanding basic immunology

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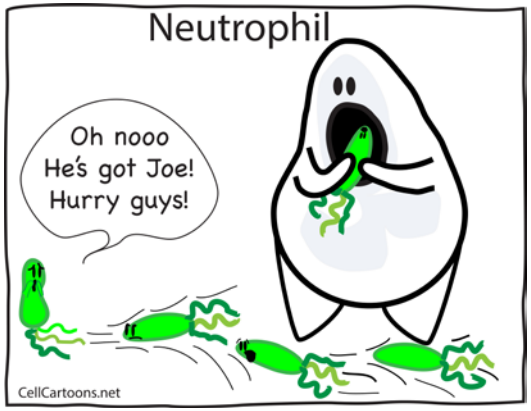
Immunology



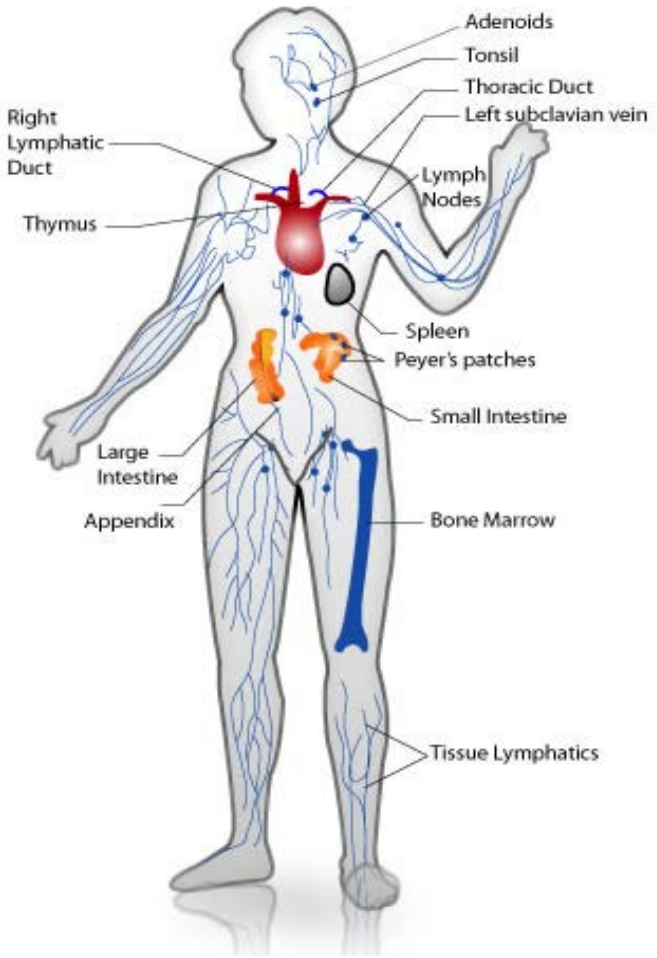
- Immunology
  - the study of how the body fights disease and infection

- Immunity
  - State of being able to resist a particular infection or toxin

Overview

- Function of defences
- Immune response to infection and vaccines
- Generating specific immunity
- Enhancing the immune defences

Functions of the immune system



Protection

- Identify and destroy pathogens
- Cancer

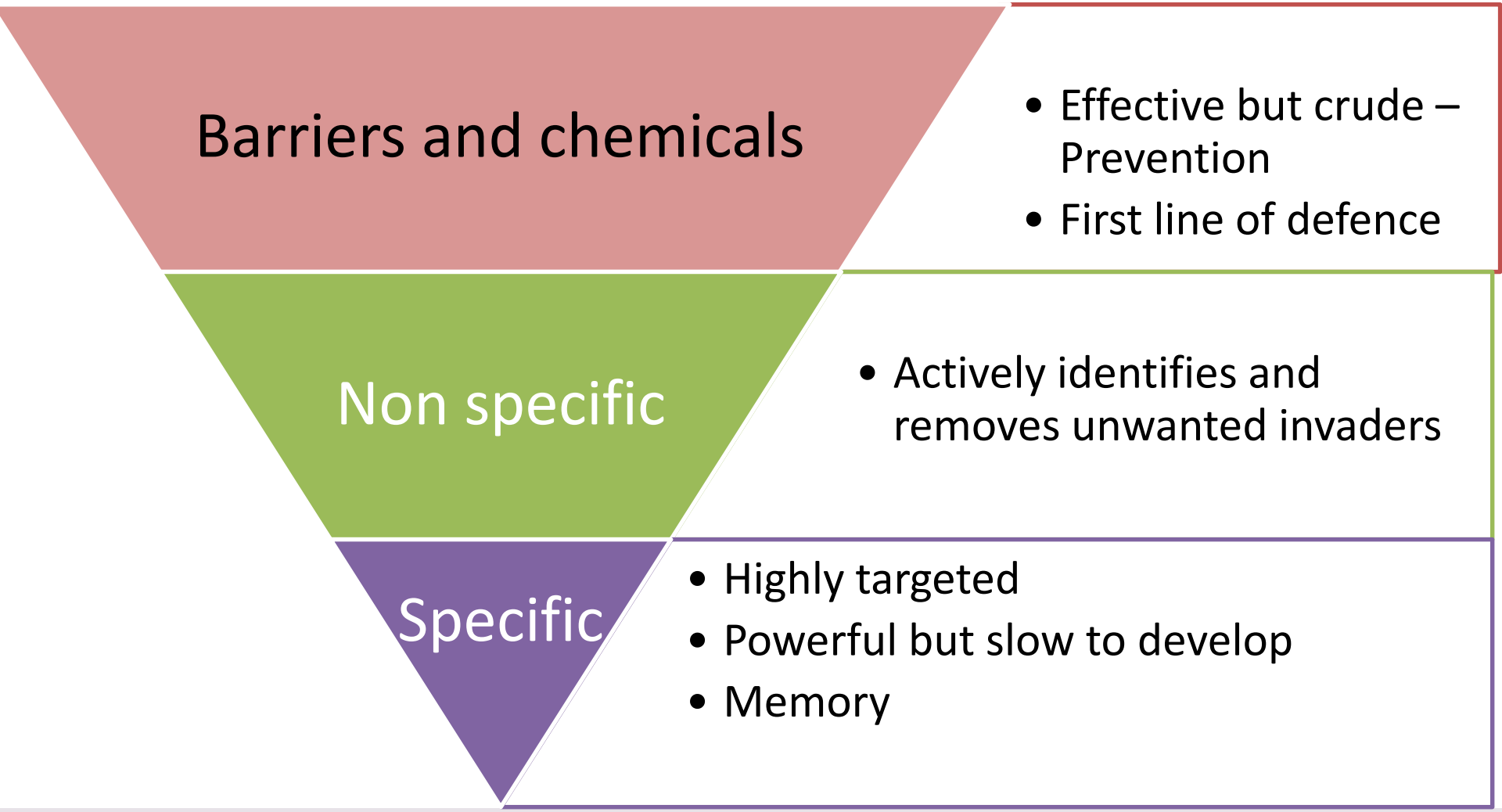
Housekeeping

- Removal of debris and dead cells
- Surveillance

Communication

- Chemical messages
- Antigen presentation
- Memory

Hierarchy of defences

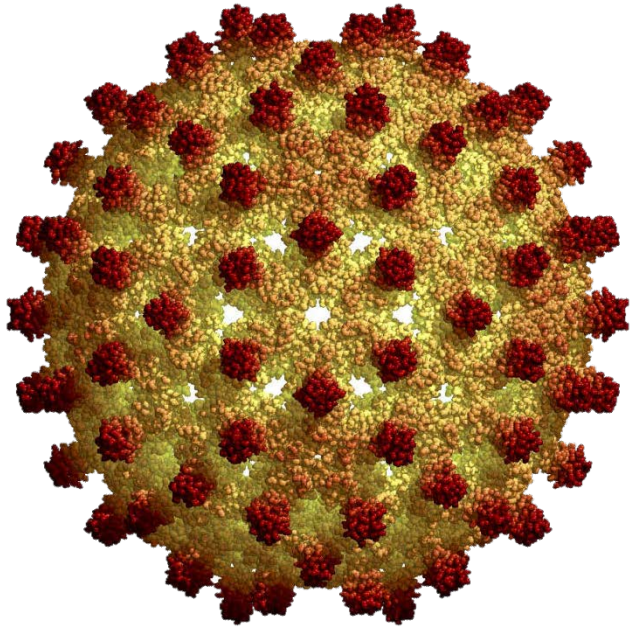


Self from non-self
First step to immunity

- Recognise molecular shapes
- Our own cells have a unique ‘self’ tags on them
- Learn to ignore ‘self’ in early development

Antigens - molecular shapes

- Drive the immune response
- Include proteins, sugars or nucleic acids
- Vaccines often contain purified antigen



Innate immunity - non-specific

Recognition and response to non-self

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Inflammation

Swelling, redness, heat

Damage → danger signal

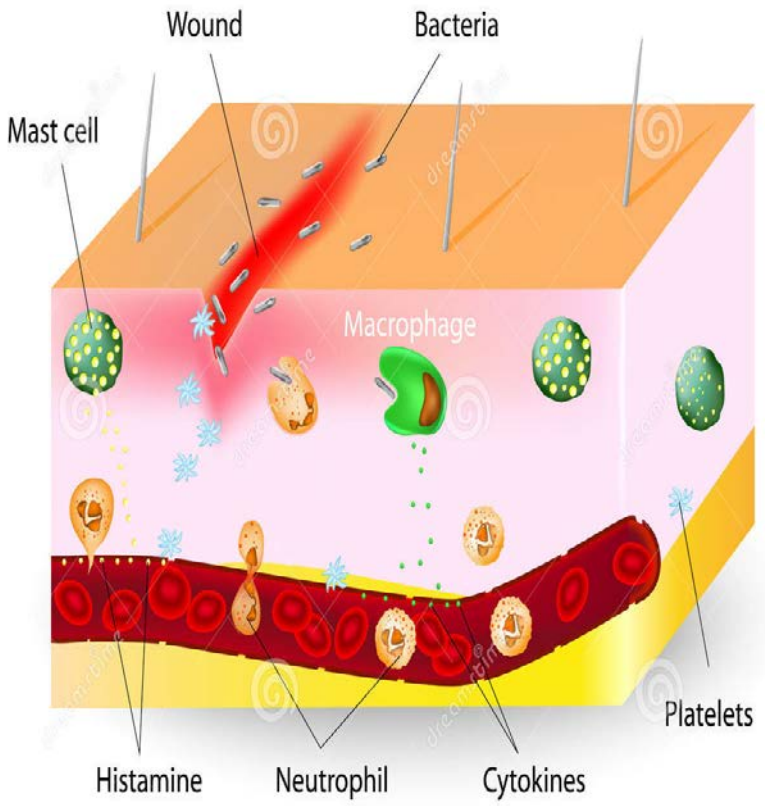
Inflammatory mediators

- Increased blood flow
- Increased capillary permeability

Attracts cells

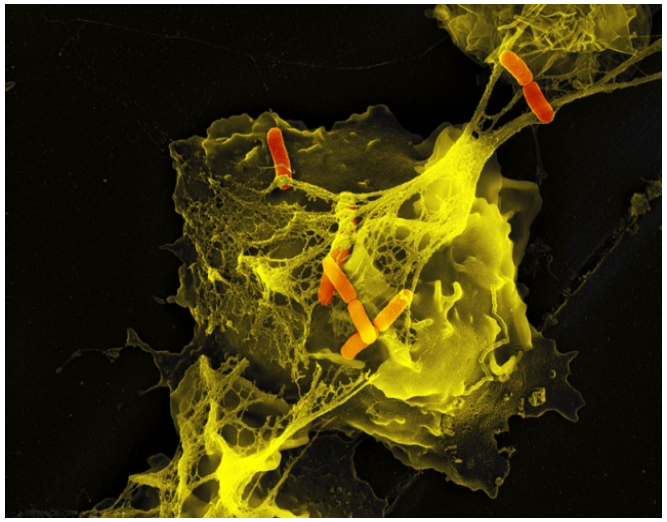
Alerts immune system

Clotting



Fight back - second line of defence

Innate response



- Identifies foreign molecular shapes
- Recognises class of microbe
- Direct killing
- Communication with chemical messengers
  - Cytokines, chemokines
- Antibodies and cytokines enhance this response

Non-specific, innate immunity

Neutrophil engulfing thrush fungus

Natural killer cells attacking a cancer cell

These cells respond to danger

Macrophage

Dendritic cell

Pictures Joel Dubin 2010

Adaptive immunity - specific

(includes humoral immunity, cellular immunity)

Antigen specific T cells and B cells

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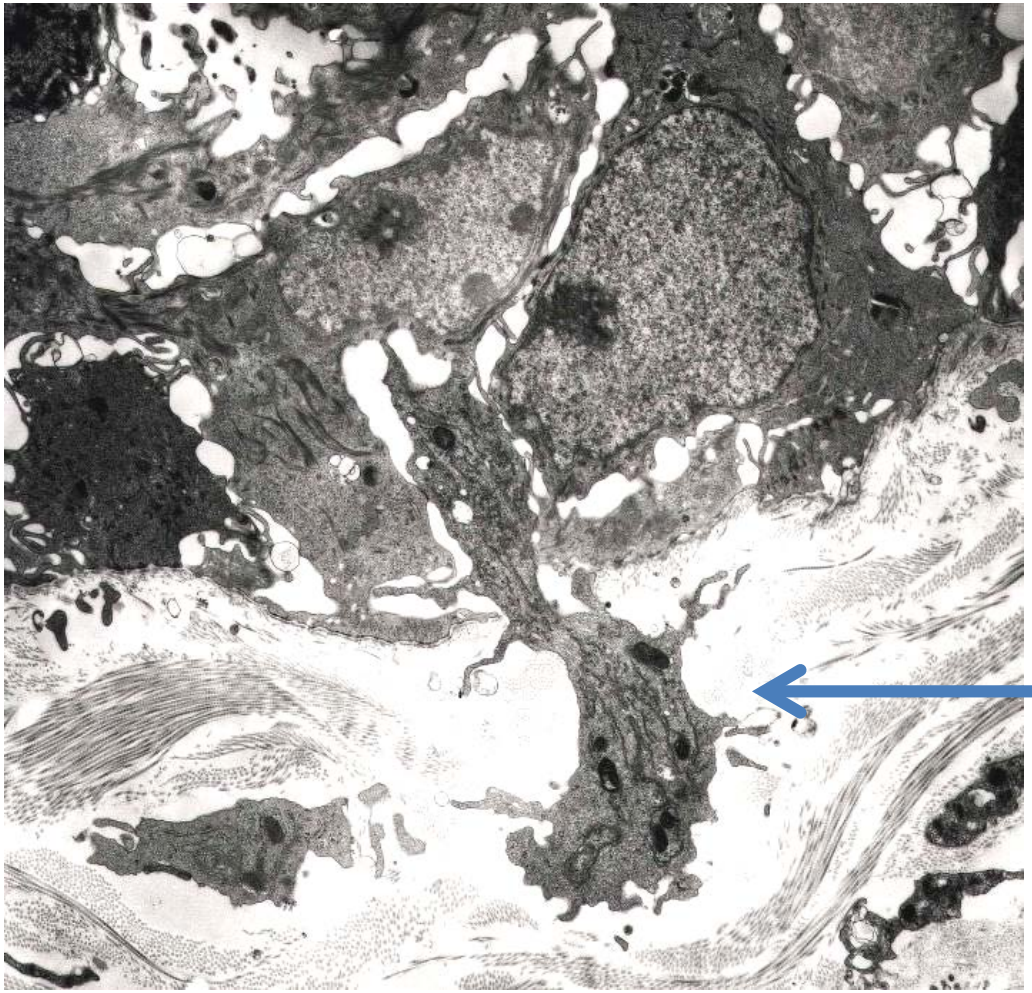
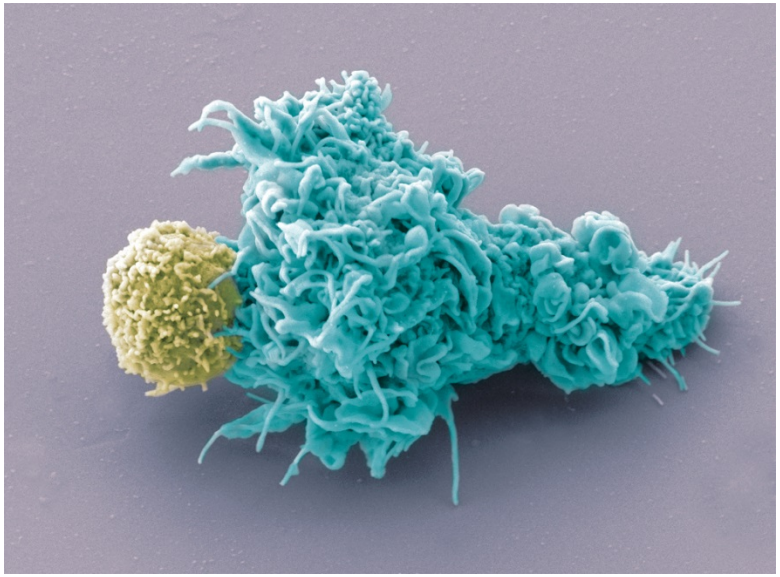
Antigen presentation



Dendritic cell entering the lymph to travel to local lymph node

Specific



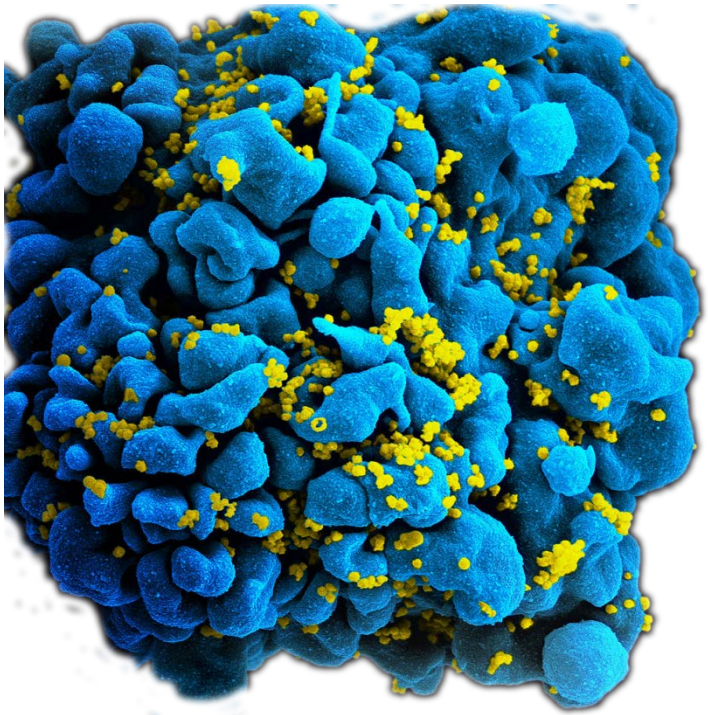
Non-specific Dendritic cell (blue) interacting with Specific T-cell (gold)

Antigen-specific T and B cells are activated in lymph nodes

T cells require three signals from antigen-presenting cells:

1. Antigen recognition
2. Co-stimulation
3. Cytokine exposure

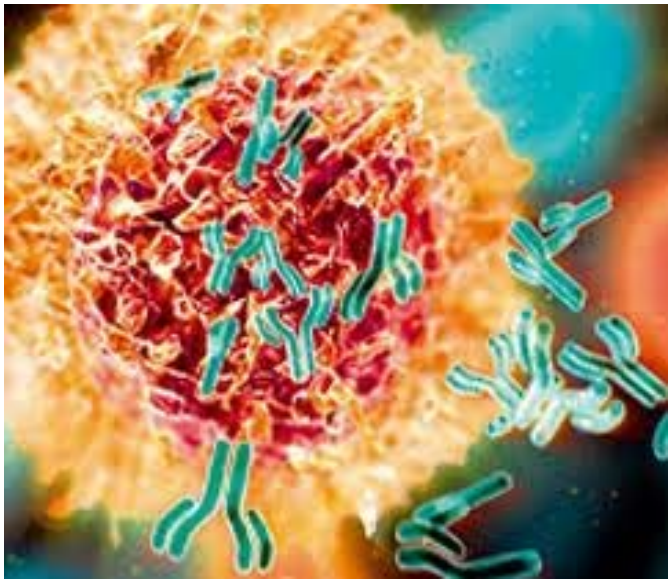
T cells



Cells infected with virus

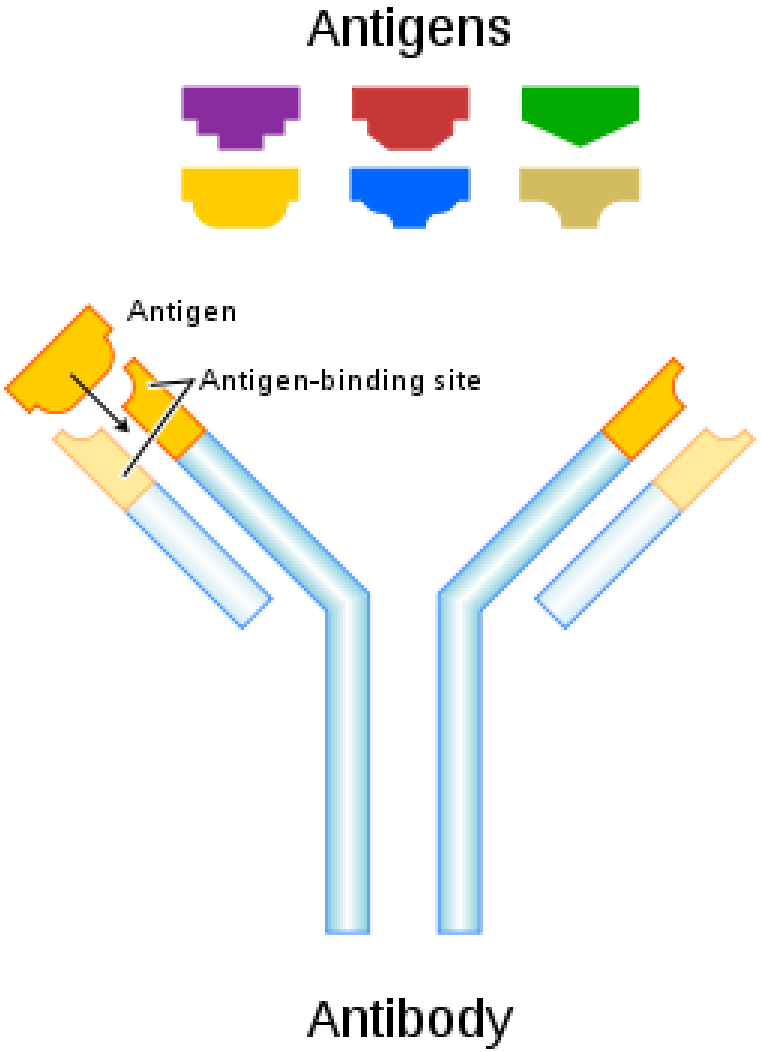
- Cytotoxic T cells
  - Kill infected cells, cancer cells
- Helper T cells
  - drive specific B-cell responses and antibody class
- Memory T-cells remain to fight the same infection another day

Specific – B cells and antibody



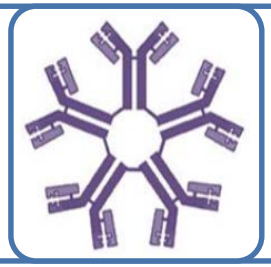
- Plasma cells
  - activated B-cells
  - secrete antigen-specific antibodies
- T cell dependent or independent responses
- Memory B-cells and antibody

Antibody – humoral immunity



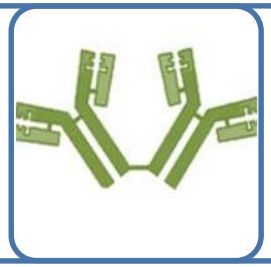
- Immunoglobulins
- Secreted by plasma cells
- Bind to specific antigen
  - Neutralise
  - Block attachment
  - Label
  - Activate complement
  - Trigger cytokine release
  - Present antigen to T cells

Key classes of antibody



IgM – low affinity, in primary immune responses; complement activation; largest Ab, does not cross placenta

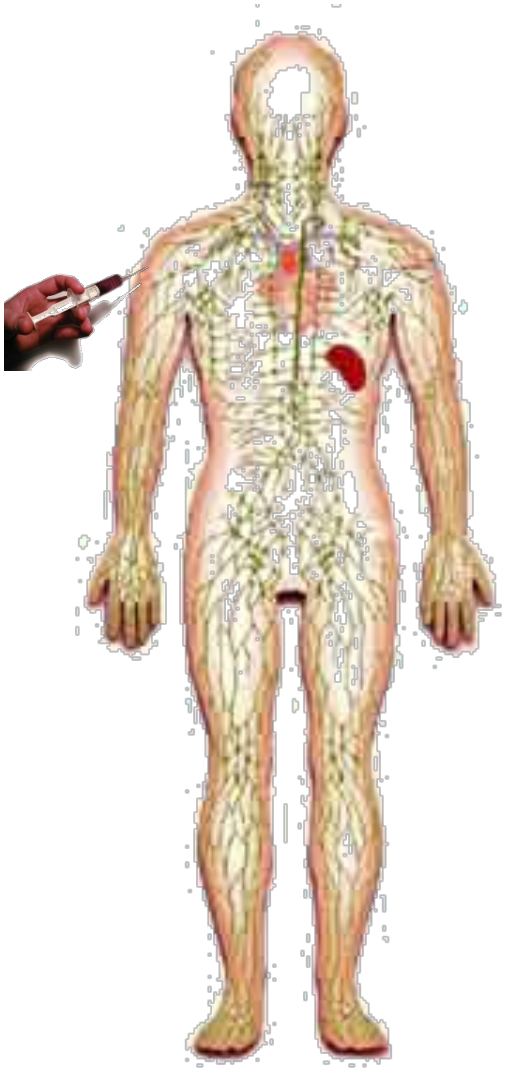
IgG – high affinity, most important class of Ab in secondary immune responses, crosses the placenta

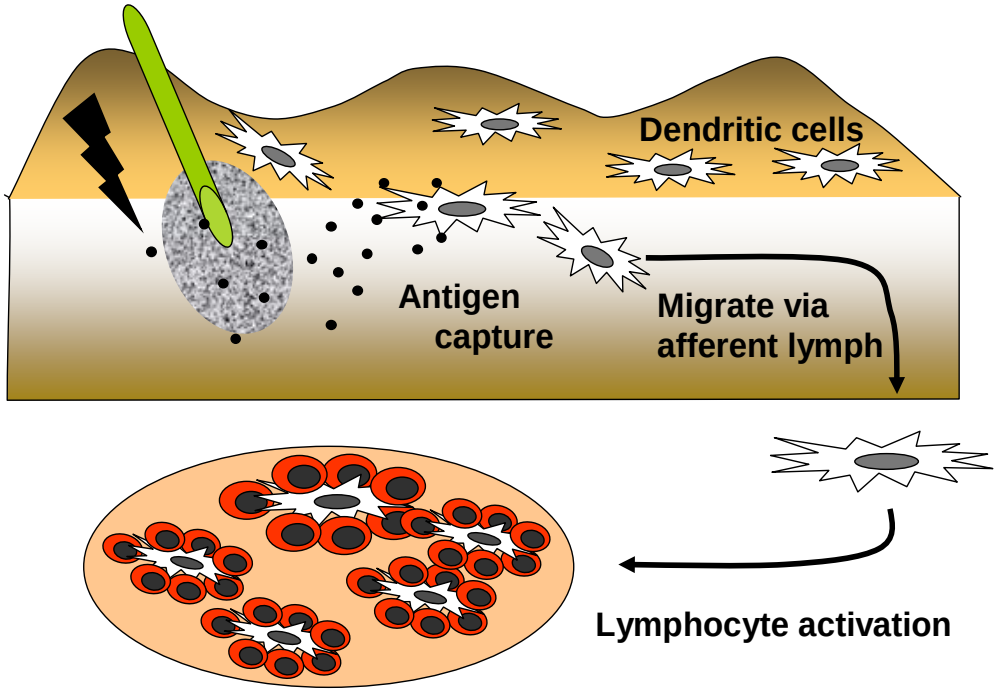


IgA - found primarily in secretions such as breast milk, tears, saliva and mucosal membranes

IgE - Evolved to provide protection for parasitic infections; associated with allergic diseases e.g. asthma & hay fever; histamine release

What happens to the injected vaccine?





- Antigen carried to lymph node where specific response takes place
- Other ingredients excreted via blood, kidneys, urine.

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Development of specific immunity

Primary immune response

- Activation of T and B cells
- Antibody produced by short-lived plasma cells
- Low affinity antibody appears in serum - IgM
- Takes 2 weeks, peaks around 30 days

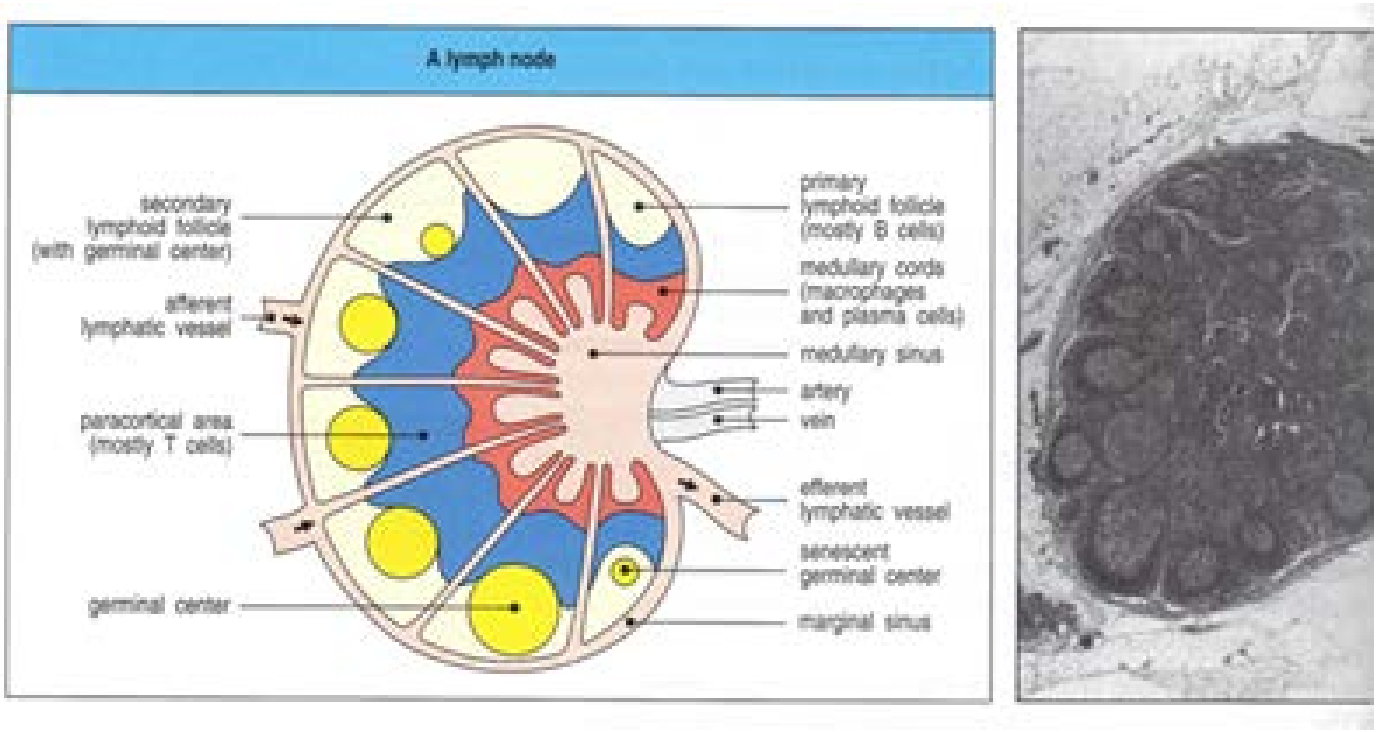
Immune memory

- Immune memory is slow - at least four months
- T cell dependent
- High affinity IgG
- Only immune memory can be ‘boosted’

Secondary response

- rapid (4 days)

Lymph node



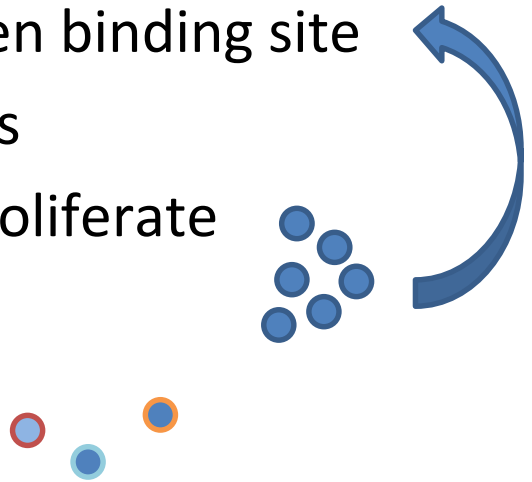
- **Cortex** – containing dividing B cells and T cells
- **Medulla** – macrophages and antibody producing plasma cells
- **Sinuses** – net of reticular fibres spanning lymphatic capillaries

Picture: C Janeway et al Immunobiology

Specific immunity – generation of high affinity antibodies

Affinity maturation – in germinal centres

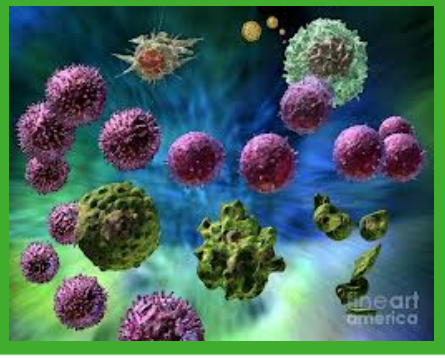
1. Activated B cells proliferate
2. Mutations in DNA coding for antigen binding site
3. Presented antigen by DC and T cells
4. Positive – high affinity => clones proliferate
5. Negative – low affinity => death †



- Differentiation and class switching - IgM to IgG – long lived memory

Summary

From microbial recognition to adaptive response and memory



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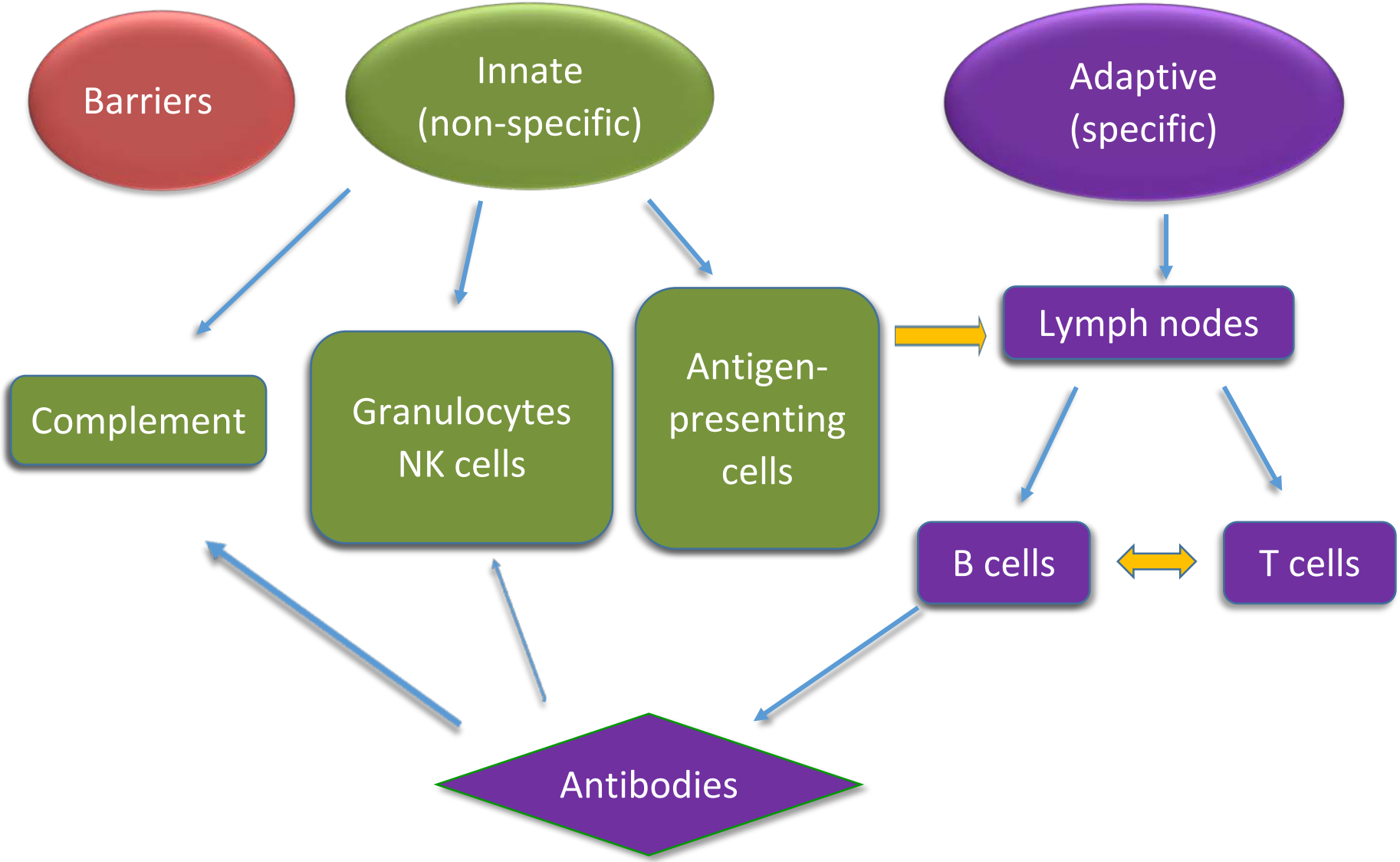
Innate works with adaptive immunity



Immune memory

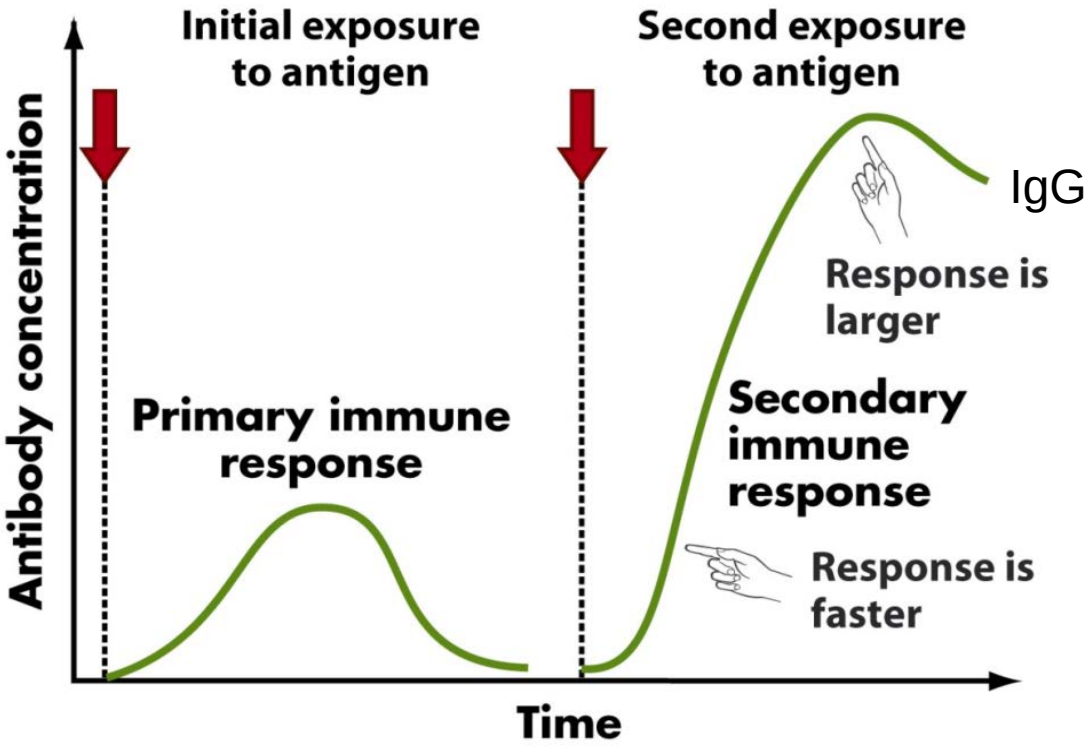


Figure 49-16 Biological Science, 2/e
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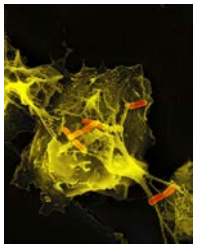
- Specific, adaptive immunity
- Long lived protection from reinfection

Communication enhances immunity

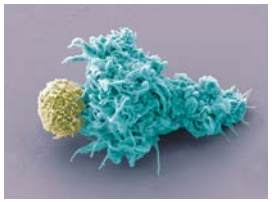


Specific antibodies label targets

Innate

IL-5
IL-4
IL-2
IFN-γ

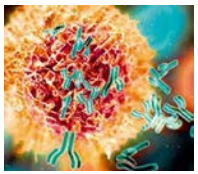
Antigen presented by DC



IL-1
IL-6
IL-12

Adaptive

- Instruct B cells
- Enhance innate response
- New cell production



Antigen-specific T and B cells activated