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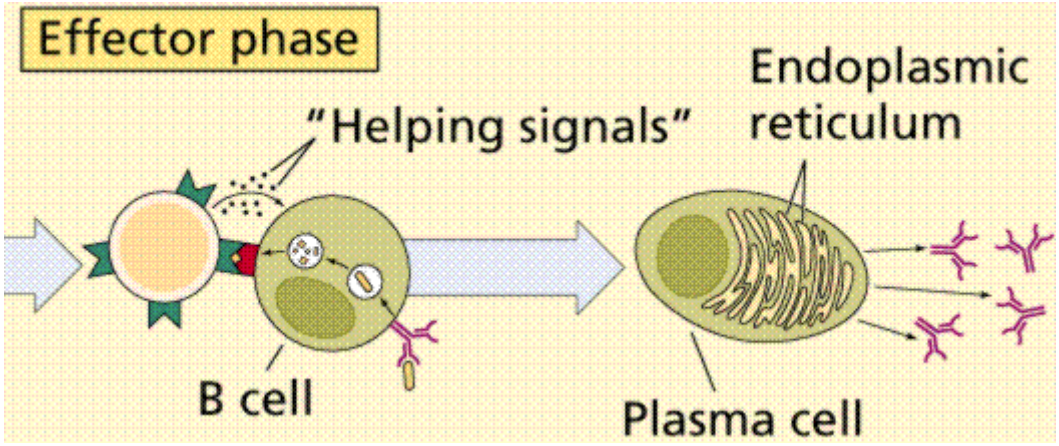
How plasma cell produce antibodies?



What is plasma cell?

- A type of WBC that produces and secretes antibodies.
- Also called plasma B cell or plasmocytes
- Originated in bone marrow
- They travel to spleen or lymph nodes to secrete antibodies

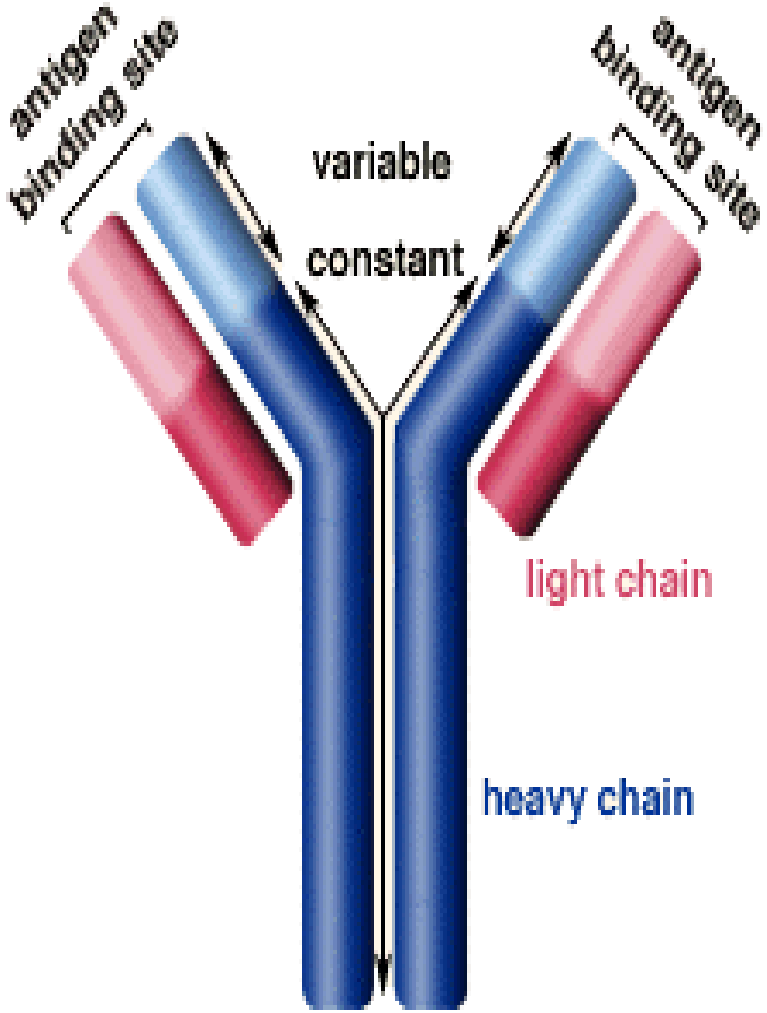
What is antibodies?

- Antibodies = Ab
- Also called Immunoglobulin (Ig)
- Specific → each react with only one type of antigen
- Antibody binding sites
  = idiotype / paratope
- Specific protein in antigen
  =epitope

What is antibodies?

- Antibody recognize the specific epitope, so it will bind with the antigen
- Bonding between Ab and Ag is not covalent
- Hydrogen bond, Van der Walls forces and hydrophobic interactions
- Y shaped

Antibody structure



-Parts of the antibody (Ab) are **constan**t,

- i.e., the same for every antibody

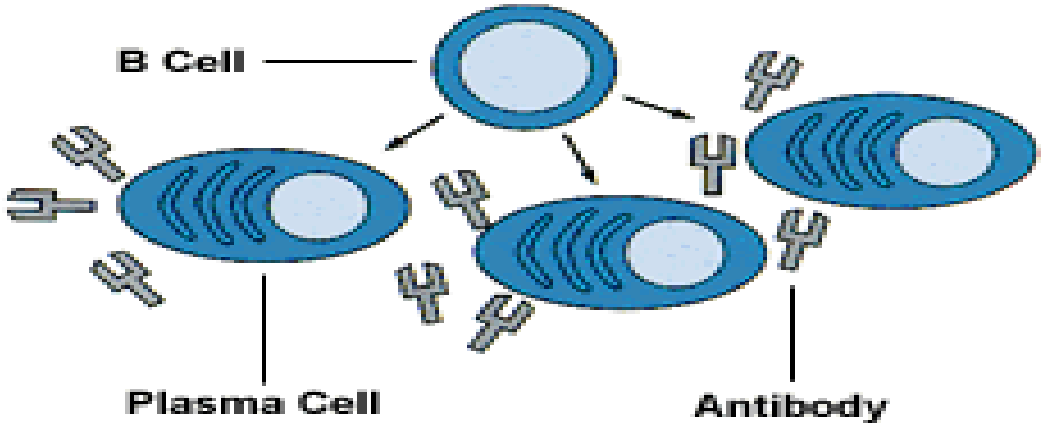
- Parts are **variable** - the arms of the "Y" have different amino acid sequences that cause specific binding to antigen

Antibodies productions

- Once Ab bind with Ag, Ab start to divide rapidly
- B cells are activated
- Matured B cell differentiate into plasma cell and memory cell
- Stimulation by [CD4 + lymphocytes]
- Proliferation form plasma cell and memory cell

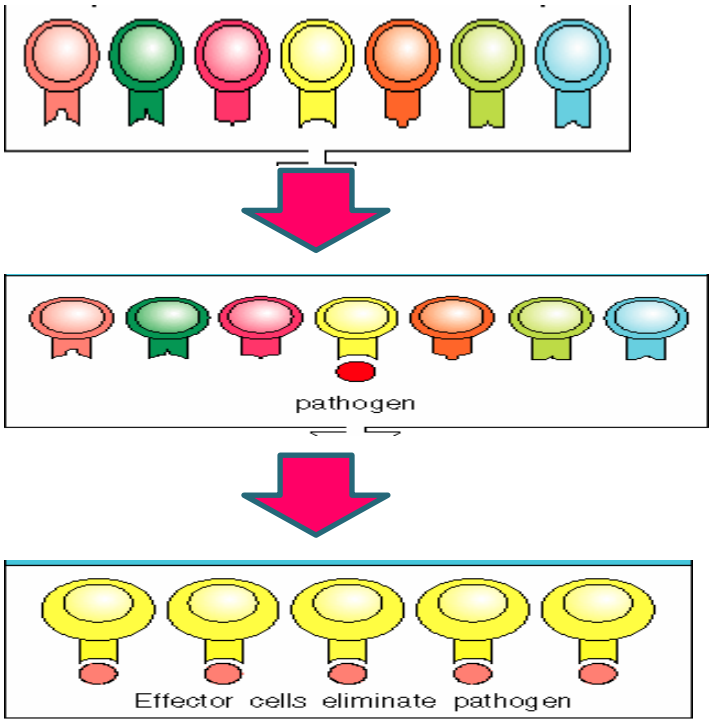
Antibodies production

- Plasma cell enlarge, divide and differentiates into clones
- Plasma cells secrete specific antibodies that circulate in the lymph & blood to reach the site of invasion, where they bind to their antigens.



Antibodies production

- If the B cells contact with the specific antigen, it divides rapidly to form a clone or identical cells
- Process known as CLONAL SELECTION



Different types of B cells have different receptor molecules

When a pathogen (germ) "locks on" to a receptor, that type of B cell is **selected**

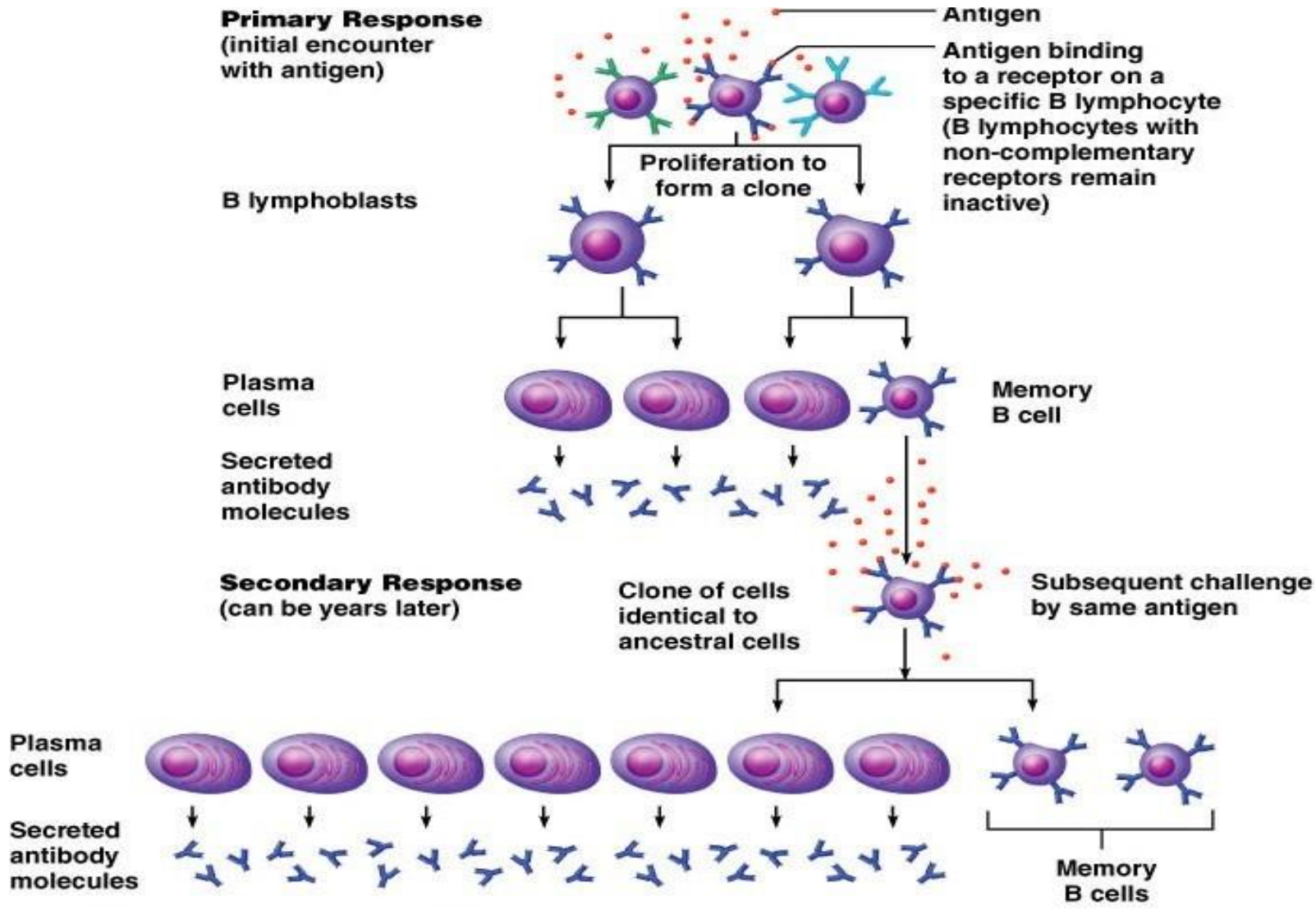
The selected B cell divides rapidly to make lots of copies of itself. The copies make lots of antibodies against the pathogen.

Antibodies productions

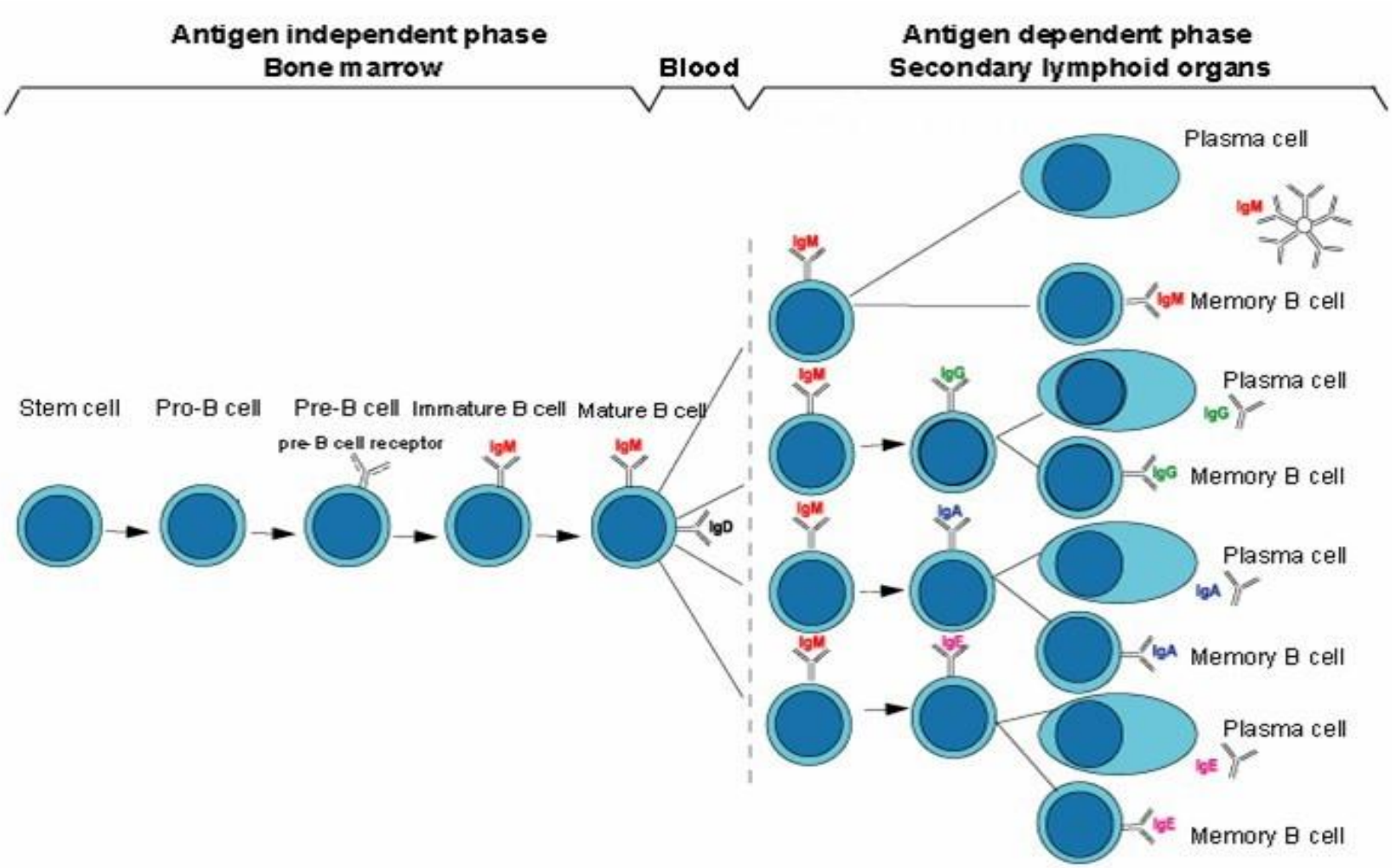
- Some of the activated B cell becomes memory cells
- Memory cell continues to produce small amounts of antibodies after the infection have overcome
- Fx →So body will be ready if the same infections occur

  →The reactions becomes faster
- Secondary immune system components
- Remain in circulation for a long time

Antibodies productions



Antibodies productions



Antibodies reactions

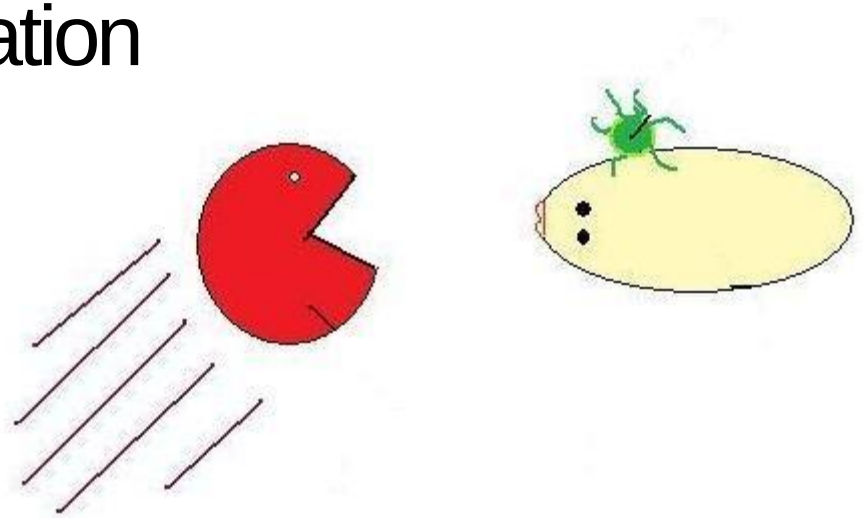
- When an antibody binds to an antigen on a cell, it acts as a signal for neutrophils, eosinophils, basophils, & macrophages to engulf & kill (phagocytose) it
- This process is known as **OPSONISATION**.
- Opsonisation is mediated by **COMPLEMENT COMPONENTS**.

Antibodies reactions

- Complement will bind to the pathogen
- Signal is released to attract phagocytic cell such as macrophages and eosinophils.
- The pathogen is engulfed and killed
- Examples of opsonin molecules are **C3b** and **C4b**

Opsonization

- Complement bind to bacteria
- Signal attract macrophages
- Macrophages go to the bacteria
- Bacteria is engulfed and killed
- Most phagocytic binding cannot occur without opsonization



Application

- The principle of vaccination is based on immunological memory.
- The initial vaccination introduces an antigen and make a primary response.
- The initial B and T cell selection step and activation.
- Next time exposures to the antigen activate memory T and B cells, and their response and production of antibody is faster.
- It is quick enough to eliminate the antigen before disease symptoms occur

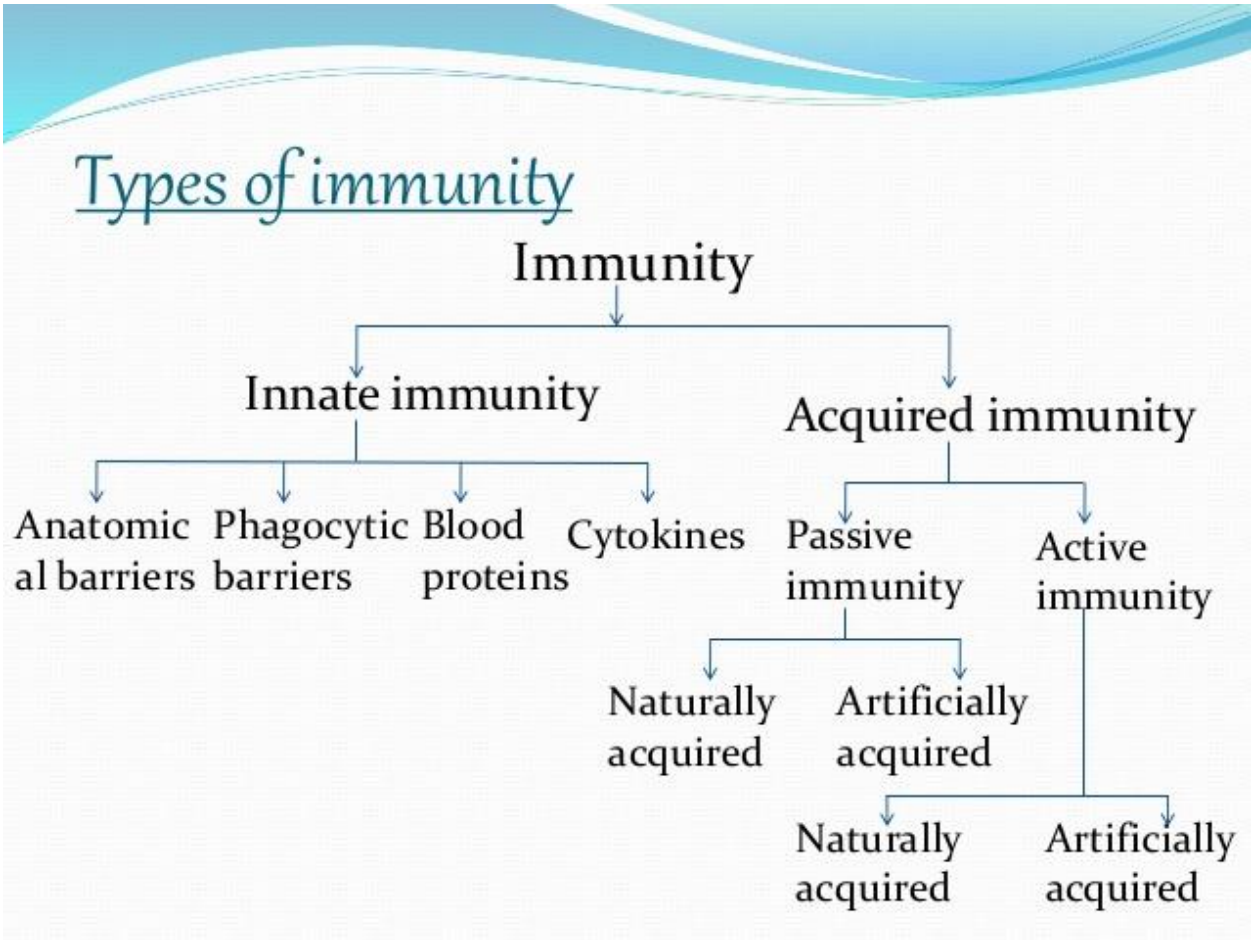
. Immunity and Types

Definition:

Immunity is the ability of the body to protect against all types of foreign bodies like bacteria, virus, toxic substances, etc. which enter the body.

Immunity is also called disease resistance. The lack of immunity is known as susceptibility.

Types of Immunity:



There are two major types of immunity: innate or natural or nonspecific and acquired or adaptive.

(A) Innate or Natural or Nonspecific Immunity (L. innatus = inborn):
Innate immunity is inherited by the organism from the parents and protects it from birth throughout life. For example humans have innate immunity against distemper, a fatal disease of dogs.

As its name nonspecific suggests that it lacks specific responses to specific invaders. Innate immunity or nonspecific immunity is well done by providing different barriers to the entry of the foreign agents into our body. Innate immunity consists of four types of barriers— physical, physiological, cellular and cytokine barriers.

1. Physical Barriers:
They are mechanical barriers to many microbial pathogens. These are of two types. Skin and mucous membrane.

(a) Skin:
The skin is physical barrier of body. Its outer tough layer, the stratum corneum prevents the entry of bacteria and viruses.

(b) Mucous Membranes:
Mucus secreted by mucous membrane traps the microorganisms and immobilises them. Microorganisms and dust particles can enter the respiratory tract with air during breathing which are trapped in the mucus. The cilia sweep the mucus loaded with microorganisms and dust particles into the pharynx (throat). From the pharynx it is thrown out or swallowed for elimination with the faeces.

2. Physiological Barriers:

The skin and mucous membranes secrete certain chemicals which dispose off the pathogens from the body. Body temperature, pH of the body fluids and various body secretions prevent growth of many disease causing microorganisms. Some of the important examples of physiological barriers are as follows:

(a) Acid of the stomach kills most ingested microorganisms,

b) Bile does not allow growth of microorganisms,

(c) Cerumen (ear wax) traps dust particles, kills bacteria and repels insects,

(d) Lysozyme is present in tissue fluids and in almost all secretions except in cerebrospinal fluid, sweat and urine. Lysozyme is in good quantity in tears from eyes.

(e) Nasal Hair. They filter out microbes and dust in nose,
(f) Urine. It washes microbes from urethra,

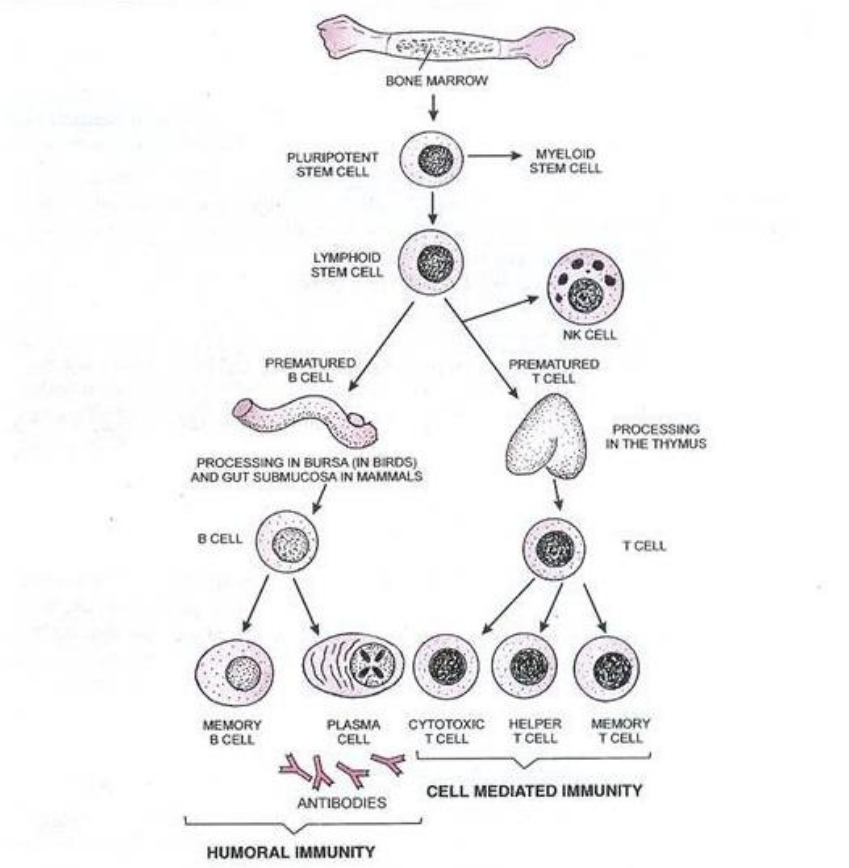
3. Cellular Barriers: These are certain white blood corpuscles (leucocytes), macrophages, natural killer cells, complement system, inflammation, fever, antimicrobial substances, etc.

4. Fever:

Fever may be brought about by toxins produced by pathogens and a protein called endogenous pyrogen (fever producing substance), released by macrophages.

(B) Acquired Immunity (= Adaptive or Specific Immunity):

The immunity that an individual acquires after the birth is called acquired or adaptive or specific immunity. It is specific and mediated by antibodies or lymphocytes or both which make the antigen harmless.



Development of B and T lymphocytes. Both arise from bone marrow precursors.
Natural killer (NC) cells are a third population of lymphocytes that are distinct from T cells and B cells.

Types of Acquired Immunity:

Acquired (= Adaptive) Immunity is of two types: active immunity and passive immunity.

1. Active Immunity:

In this immunity person's own cells produce antibodies in response to infection or vaccination. It is slow and takes time in the formation of antibodies. It is long lasting and is harmless. Active immunity may be natural or artificial.

(a) A person who has recovered from an attack of small pox or measles or mumps develops natural active immunity.

(b) **Artificial active immunity** is the resistance induced by vaccines. Examples of vaccines are as follows: Bacterial vaccines, (a) Live- BCG vaccine for tuberculosis, (b) Killed vaccines- TAB vaccine for enteric fever. Viral vaccines, (a) Live – sabin vaccine for poliomyelitis, MMR vaccine for measles, mumps, rubella, (b) Killed vaccines- salk vaccine for poliomyelitis, neural and non-neural vaccines for rabies. Bacterial products. Toxoids for Diphtheria and Tetanus.

2. Passive Immunity:

When ready-made antibodies are directly injected into a person to protect the body against foreign agents, it is called passive immunity. It provides immediate relief. It is not long lasting. It may create problems. Passive immunity may be natural or artificial.

(a) Natural passive immunity is the resistance passively transferred from the mother to the foetus through placenta. IgG antibodies can cross placental barrier to reach the foetus. After birth, immunoglobulin's are passed to the new-born through the breast milk. Human colostrum (mother's first milk) is rich in IgA antibodies. Mother's milk contains antibodies which protect the infant properly by the age of three months.

(b) Artificial passive immunity is the resistance passively transferred to a recipient by administration of antibodies. This is done by administration of hyper-immune sera of man or animals. Serum (pi. sera) contains antibodies. For example, anti-tetanus serum (ATS) is prepared in horses by active immunisation of horses with tetanus toxoid, bleeding them and separating the serum. ATS is used for passive immunisation against tetanus. Similarly anti-diphtheric serum (ADS) and anti-gas gangrene serum (AGS) are also prepared.


welcome

ORGANS OF IMMUNE SYSTEM PRIMARY AND SECONDARY LYMPHOID ORGANS

LYMPHOID ORGANS

Primary Lymphoid

- Bone marrow
- Thymus

Secondary Lymphoid

Lymph nodes

Spleen

MALT

PRIMARY LYMPHOID ORGANS

Lymphoid stem cells undergo proliferation differentiation and maturation into T and B cells.

- **Acquire antigen specific reception.**
- **After maturation T and B cells migrate to secondary lymphoid organs.**
- **In mammals - Thymus, Bone marrow**
  In Birds -Thymus, Bursa of Fabricius
- **Major sites of Lymphopoiesis**
  T cell - Thymus, B cell - Bone marrow
- **Control Peripheral Lymphoid Organs.**

THYMUS

Bilobed organ.

Situated above the heart.

Each lobe enclosed by capsule

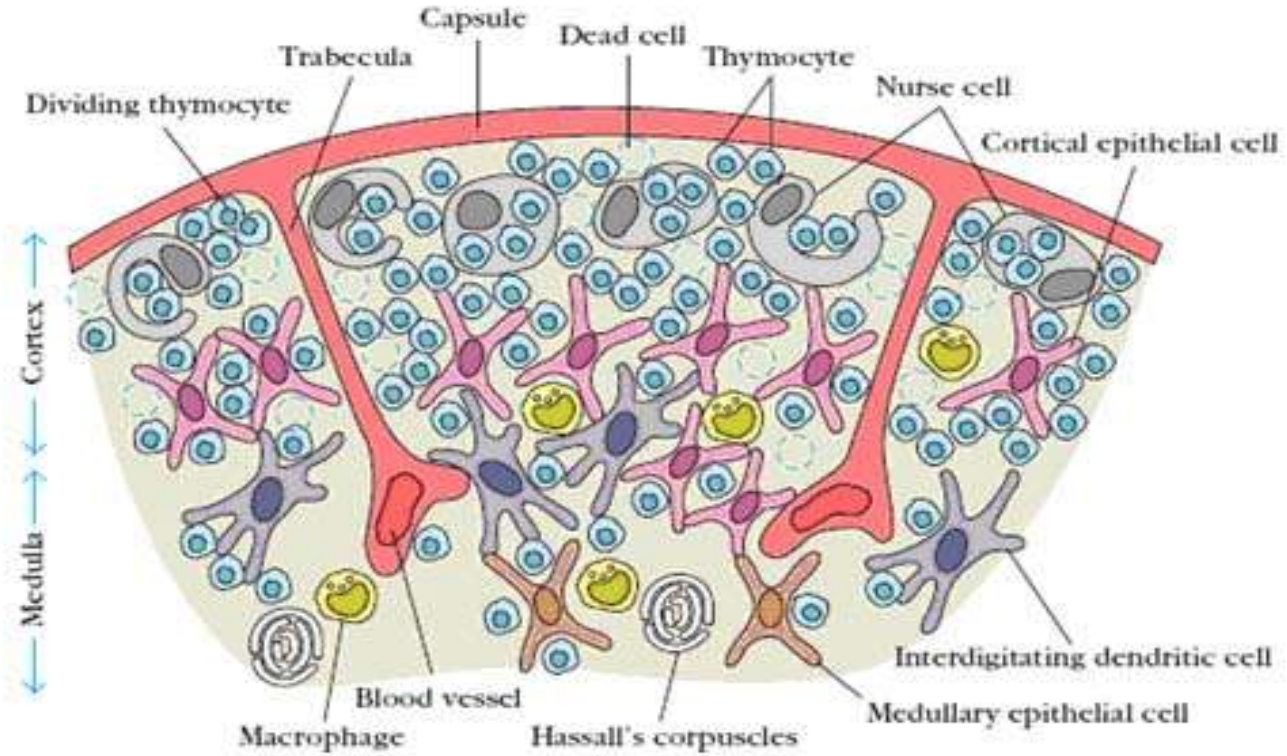
Each lobule separated by connective tissue called trabeculae.

Outer Cortex –

Inner Medulla –

- **Immature T cells in called – Thymocytes**
- **Thymic epithetical cells in outer cortex called Nurse cells.**
- **Hassall's corpuscles – contain degenerating epithelial cells.**

- Site of T cell development and maturation.
- Development of cell mediated immunity.
- Thymic epithelial cells produce hormones **thymosin** and **thymopoietin**.
- T cell receptor generated.
- Recognizing antigen MHC complex.
- T cells protect body from infection.



- **Removal of thymus from newborn mice.**
  - **Decrease in circulating lymphocytes.**
  - **Absence of cell mediated immunity.**
  - **Increase in infectious disease.**
- **Congential birth defect in humans**

  [Diveorge's Syndrome]
- **Mice – mude mice**
- **Aging – decline in thymic function**
- **Maximal size at puberty.**

BONE MARROW

Site of blood cell formation.

B cell origin and mature

E.g. Humans and Mice

Fat cells, bony tissue, dendritic cells

- Stomatal cells interact with B cells
- Secrete cytokines.
- Selection process occur.
- It is not the site of B cell development in all species.

BURSA OF FABRICIUS

- Gut associated lymphoid organs.
  [Birds]
- Lymph epithelial tissue.
- Hindgut of chicken.
- Multiply and differentiate into B lymphocytes.
- Immuno globulins synthesis.
- Described by Fabricus in 1621.
- Humoral immunity in birds.
- Absent in mammals (primates, rodents).

SECONDARY LYMPHOID ORGANS

- Organs in which antibodies are formed.
- Antigen trapping and lymph filtration mechanism.
- Receive immuno competenal cells (primary lymphoid organ for making them and active).
- Spleen
- Lymph nodes
- Mucosa associated lymphoid tissue.

LYMPH NODES

Solid encapsulated bean shaped structure.

Seen in Armpits, Mesenteries.

Network packed with lymphocytes, macrophages, dendritic cells.

Three concentric regions :-

Cortex , Para cortex, Medulla

CORTEX :-

Outer most layer

Contains lymphocytes, macrophage, follicular dendritic cells arranged in primary follicle

⇨Lymphoid tissues organized into structures - lymphoid follicle.

⇨Lymphoid follicle activated by antigen – primary follicle

[Follicular Dendritic Cell, Resting B Cell]

- Primary follicle develop into secondary follicle.
- In children with B cell deficiency cortex lack primary follicles and germinal centers.

PARACORTEX :-

[T lymphocytes, interdigiting dendritic cells].

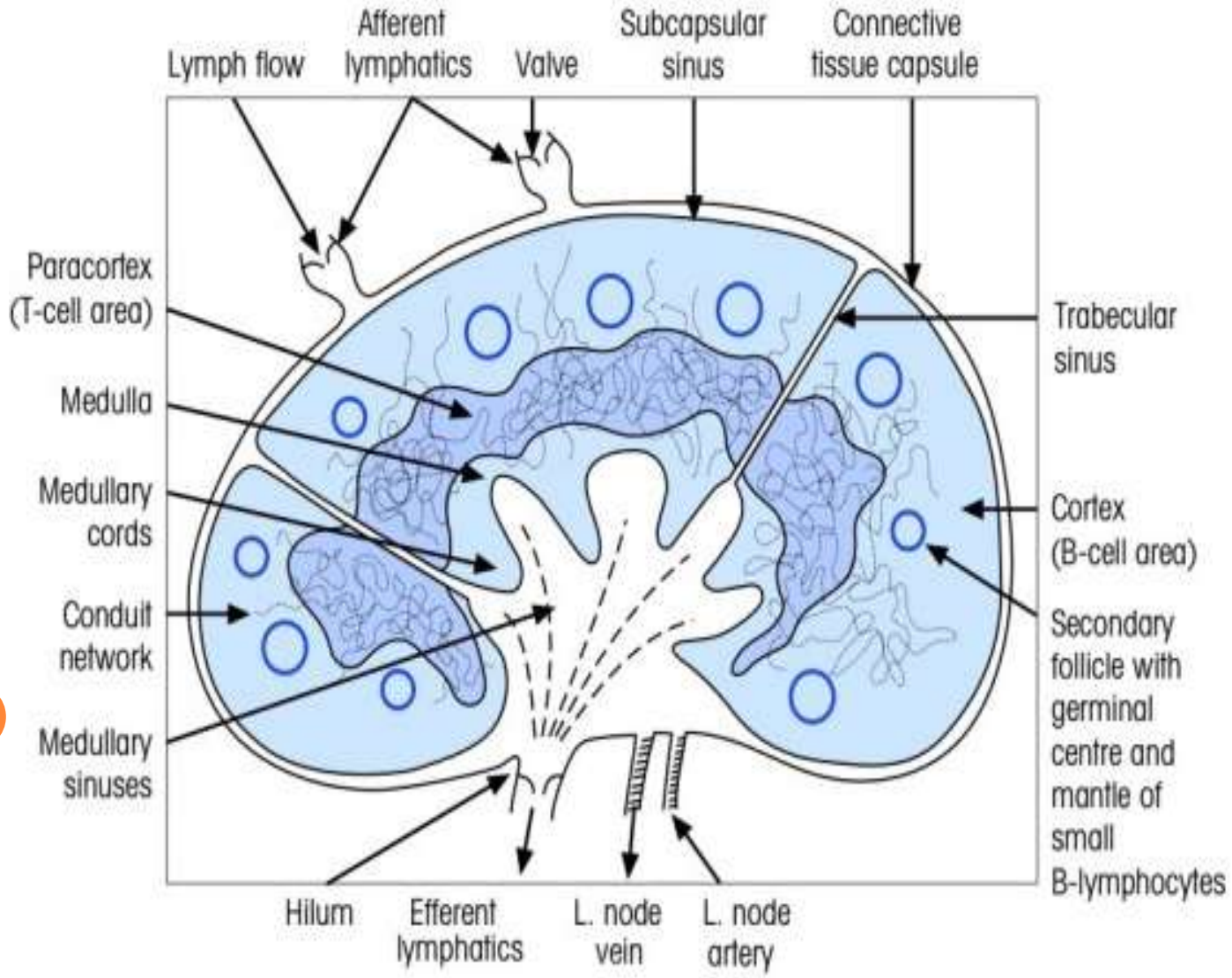
Thymus dependent area – Para cortex

Thymus independent area – Cortex

Class II MHC present.

MEDULLA :-

Inner most layer


Lymph flow
Afferent lymphatics
Valve
Subcapsular sinus
Connective tissue capsule
Paracortex (T-cell area)
Medulla
Medullary cords
Conduit network
Medullary sinuses
Trabecular sinus
Cortex (B-cell area)
Secondary follicle with germinal centre and mantle of small B-lymphocytes
Hilum
Efferent lymphatics
L. node vein
L. node artery

- Antigen reaches regional node (lymph)
- It is trapped
- Class II MHC molecules – Antigen (interdigitating dendritic cells)
- Resulting activation of T_H cells.
- Activation of B cells.

- Initial activation of B cells take place within Para cortex.
  B cells differentiate into plasma cell.
- Secreting IgG.
- Secondary follicle develop.
- (Follicular dendritic cell, B cell, T_H cell)

SPLEEN

- Bean shaped organ.
- Left side of abdominal cavity.
- Specializes in filtering blood and trapping blood borne antigens.
- Blood borne antigens, lymphocytes into spleen through splenic artery.
- Spleen surrounded by capsule.
- Two types of compartment red and white pulp.

Red pulp – network of sinusoids macrophage, RBC, lymphocyte.

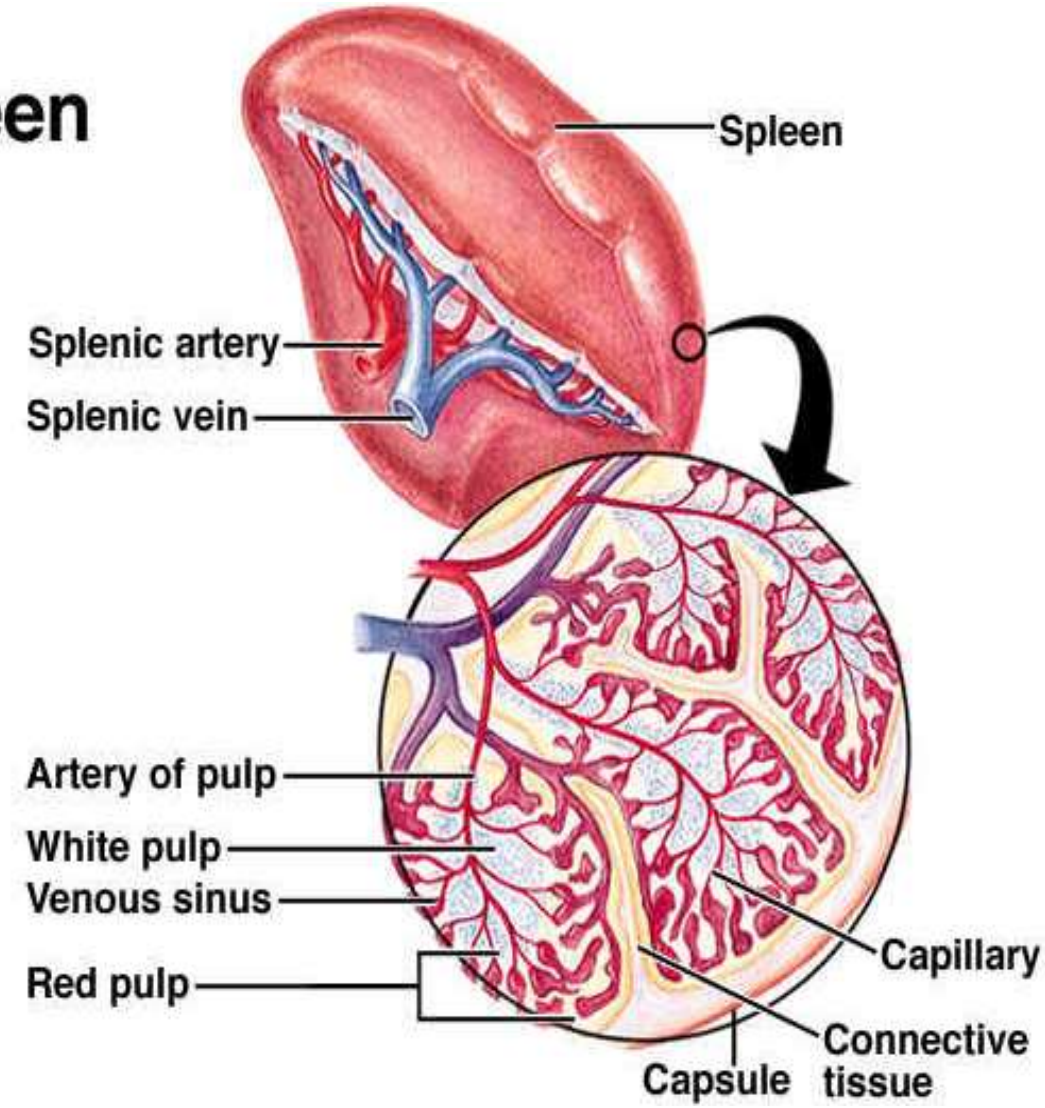
Old and defective RBC destroy.

White pulp - consist of lymphoid tissue, T and B lymphocytes.

- White pulps surrounds branches of splenic artery forming Per arteriolar Lymphoid Sheath (PALS).
- Marginal zone located peripheral to PALS

[Lymphocytes and Macrophages].

Spleen


Spleen
Splenic artery
Splenic vein
Artery of pulp
White pulp
Venous sinus
Red pulp
Capillary
Connective tissue
Capsule

- Blood borne antigen and lymphocytes
- (Splenic artery)
- Spleen
- Marginal Zone [trapped by interdigiting dendritic cells]
- PALS
- Initial activation of Band T cell in – PALS
- Dendritic cell capture antigen
- Combined with MHC molecule and TH cells
- Activates B cells
- Primary follicles in marginal zone
- Secondary follicles [germinal centre]
- Rapidly dividing B cells
- Plasma cells - antibody production

- **In children, splenectomy – increases bacterial sepsis, pneumonia, influence.**

- **Splenectomy in adult – increase in blood borne bacterial infection.**

MUCOSA ASSOSCIATED LYMPHOID TISSUE

Lymphoid tissue in mucosal epithelial surface – **MALT**

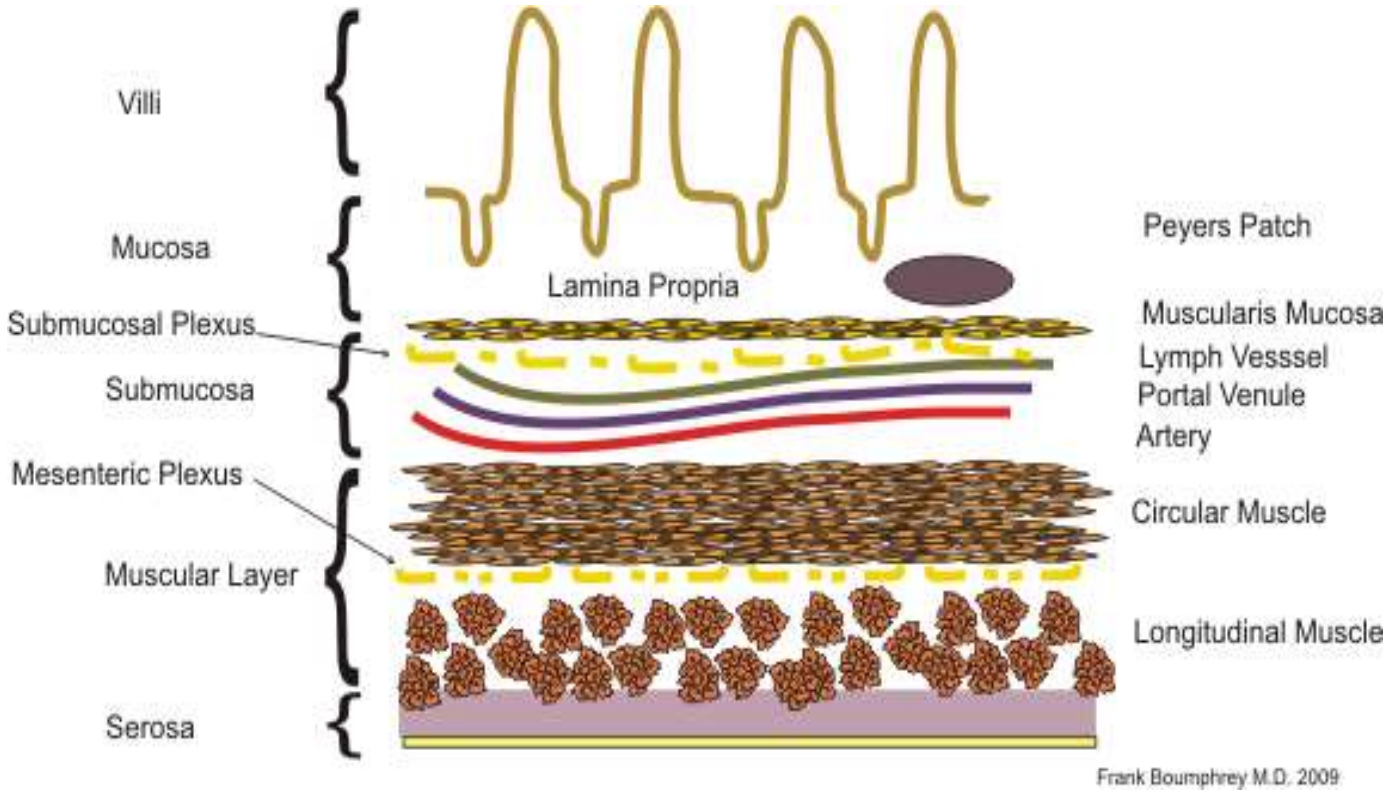
Antibody producing plasma cells.

- Nasal associated lymphoid tissue – back of nose, palate, base of tongue, tonsils
- Handling airborne microbes
- Tonsils defend against antigen entire through nasal and oral epithelial route
- Respiratory, Uriogential, Gastrointestinal tract
- The endocytose antigen from lumen
-

Mucous membrane – effective barrier

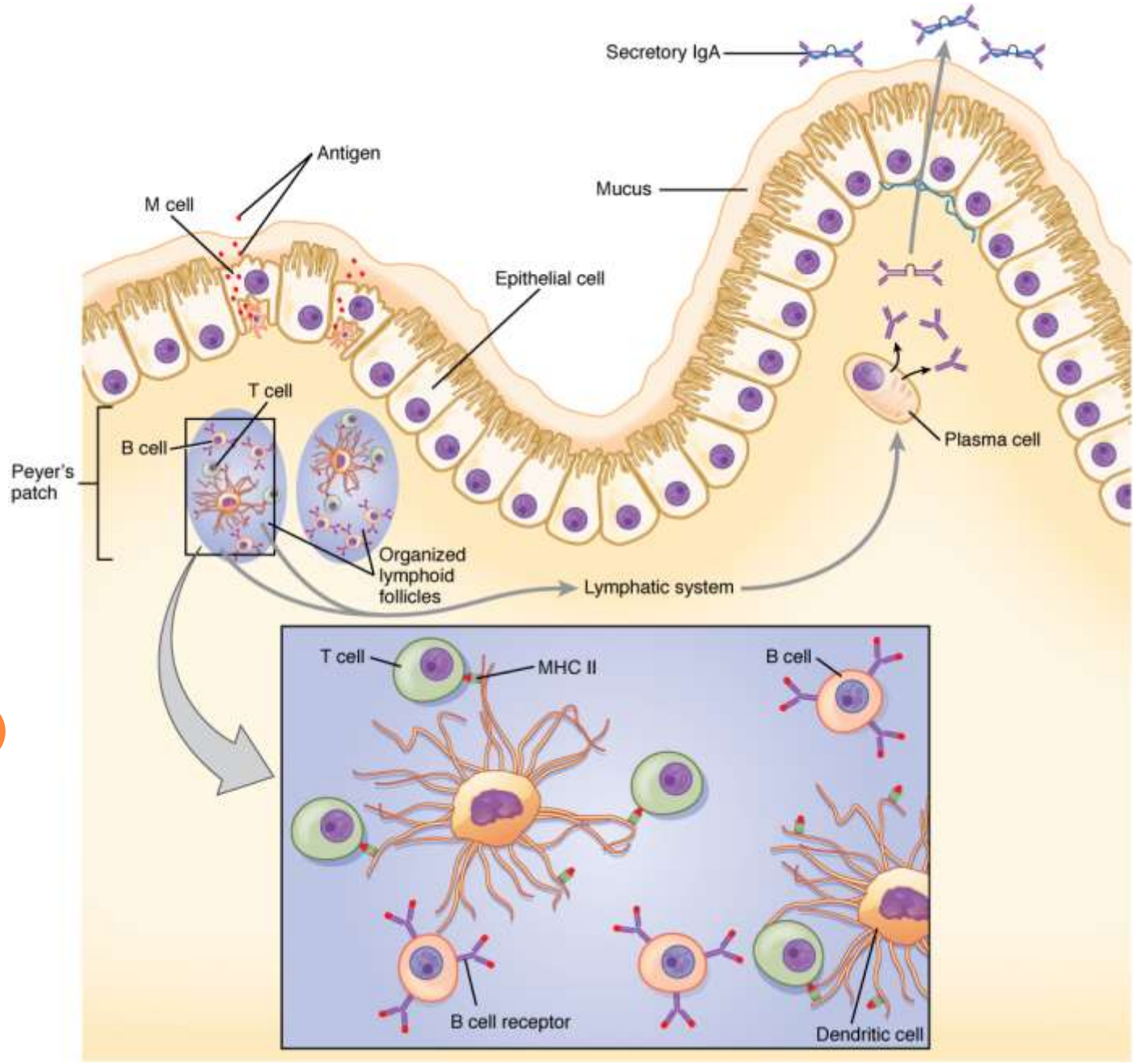
- Non specific immunity
-

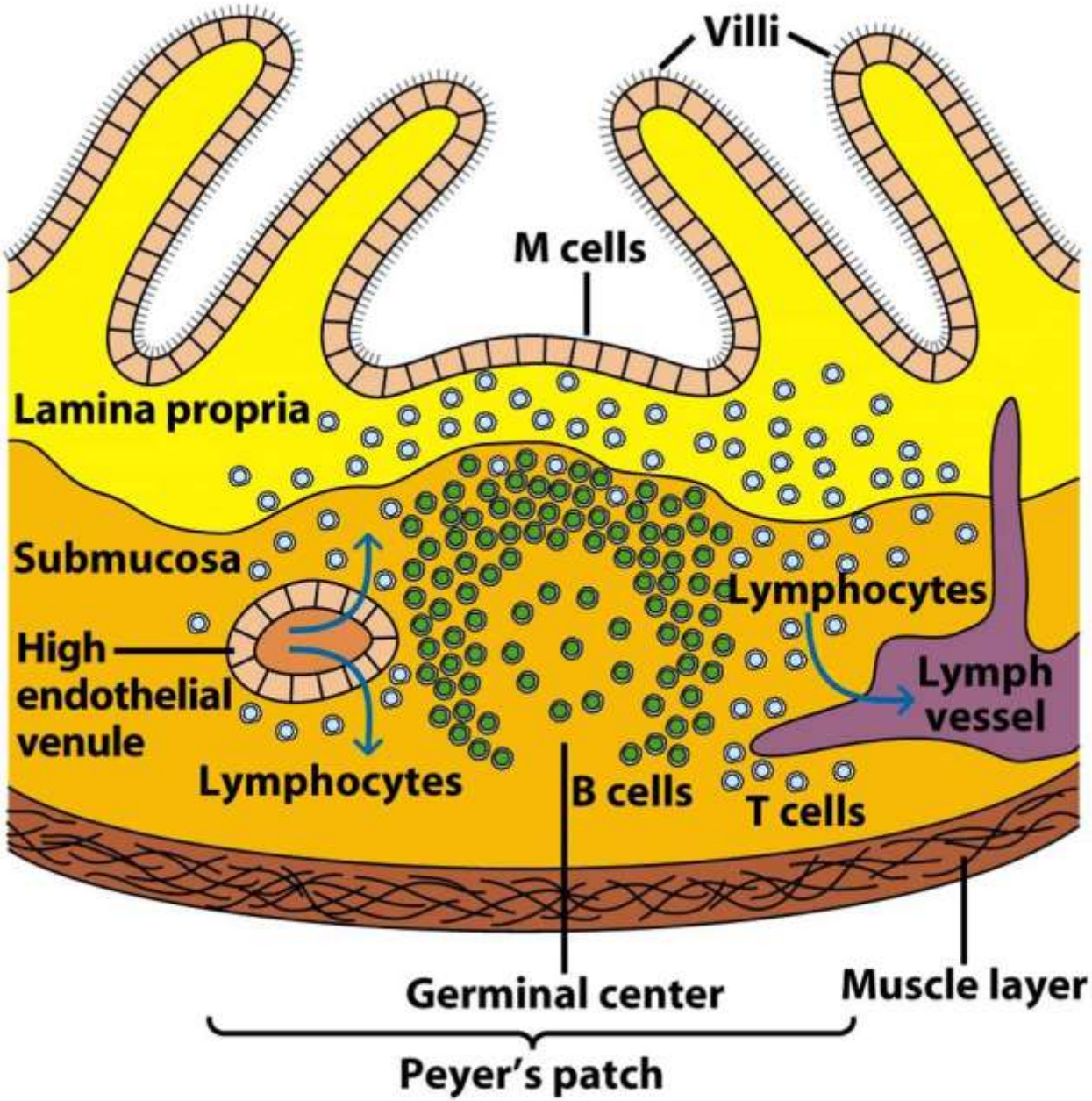
- Peyer's patches found in ileum.
- Round patches of lymphatic nodes
- Develop into secondary follicle in germinal center
- Antigen transport by specialized M cells.
- Pockets of M cells – B cells, T cells, Macrophages
- M cells locate in inductive sites

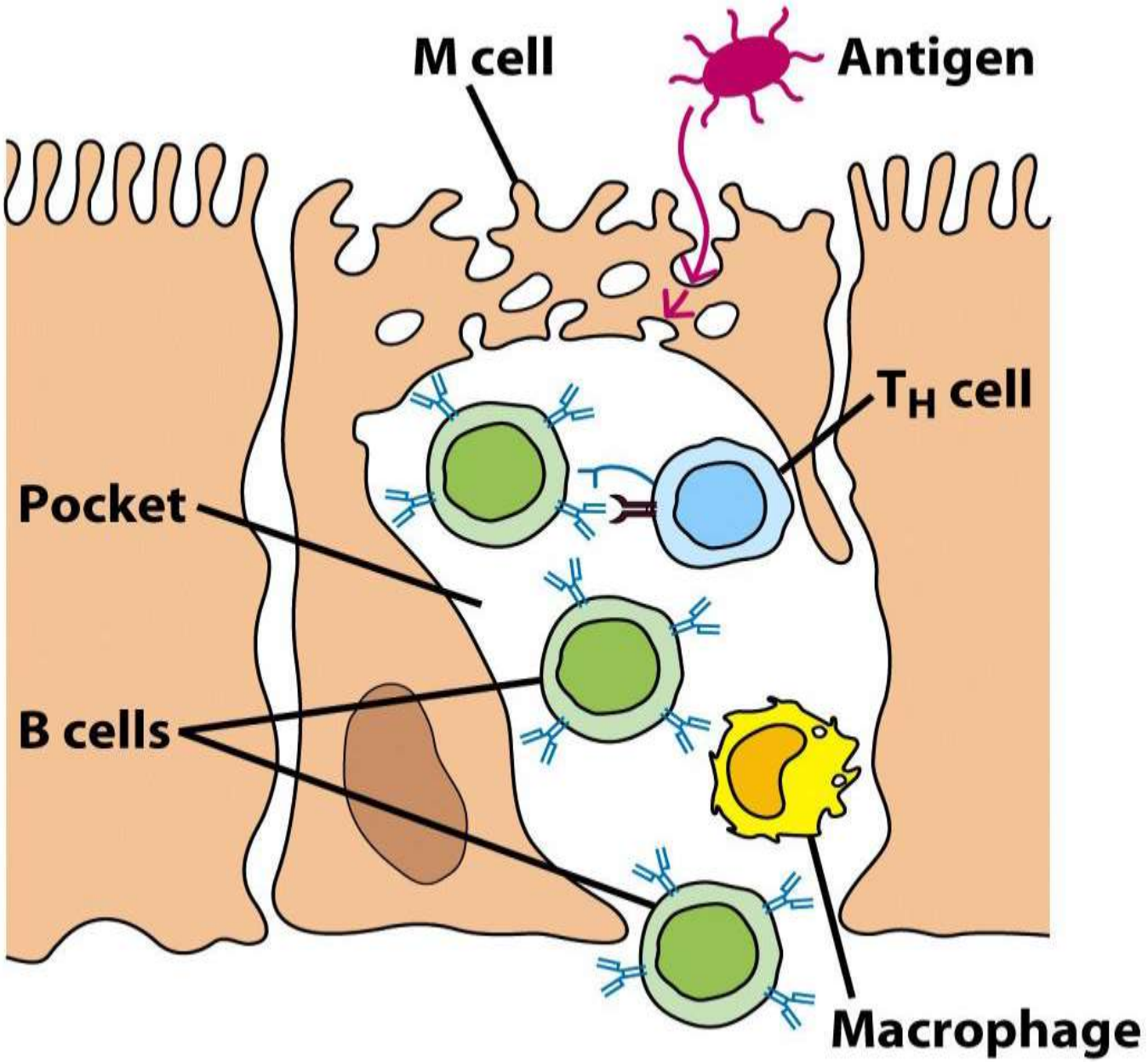


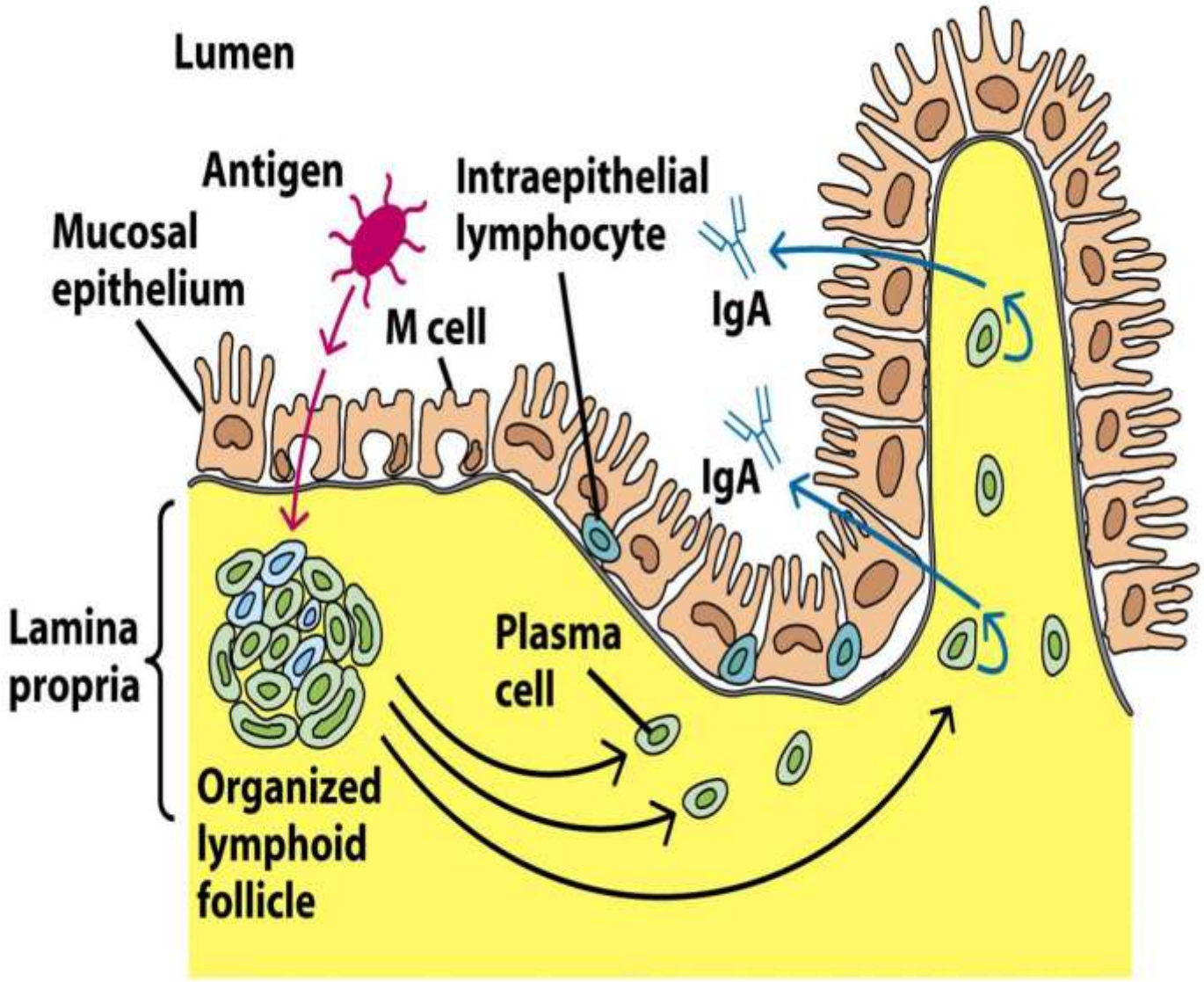
- Antigen transported across mucous membrane by M cells

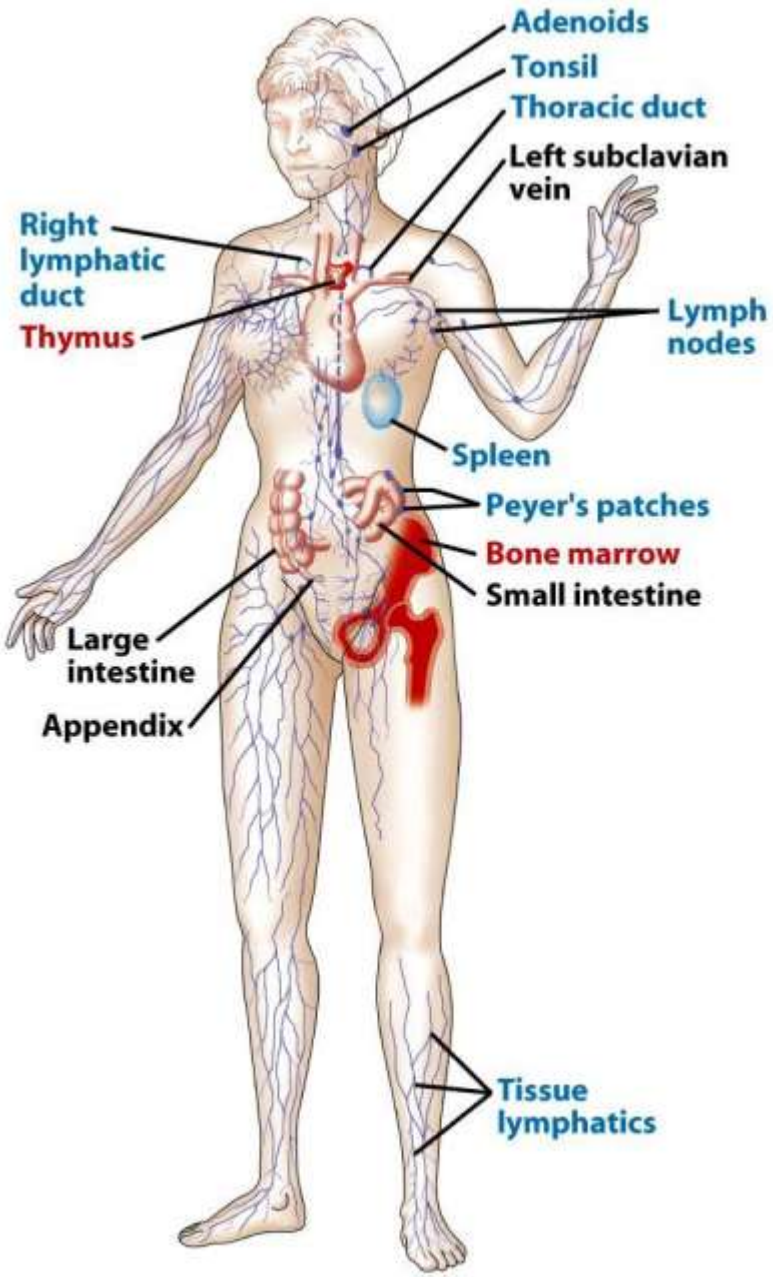
- Activate B cells in follicle
- Differentiate into plasma cells
- Secrete 1gA class of antibodies
- Transported across epithelial cells
- Secretary 1gA into lumen
- Interact with antigen


Secretory IgA
Antigen
M cell
Mucus
Epithelial cell
T cell
B cell
Peyer's patch
Plasma cell
Organized lymphoid follicles
Lymphatic system
T cell
MHC II
B cell
B cell receptor
Dendritic cell


Villi
M cells
Lamina propria
Submucosa
Lymphocytes
High endothelial venule
Lymph vessel
Lymphocytes
B cells
T cells
Germinal center
Muscle layer
Peyer's patch


M cell
Antigen
T_H cell
Pocket
B cells
Macrophage


Lumen
Antigen
Intraepithelial lymphocyte
Mucosal epithelium
M cell
IgA
IgA
Lamina propria
Plasma cell
Organized lymphoid follicle


Adenoids
Tonsil
Thoracic duct
Left subclavian vein
Right lymphatic duct
Thymus
Lymph nodes
Spleen
Peyer's patches
Bone marrow
Small intestine
Large intestine
Appendix
Tissue lymphatics


Thank You