What the immune system does

The immune system protects the body against illness and infection caused by bacteria, viruses, fungi or parasites. It is a collection of reactions and responses that the body makes to damaged cells or infection.

What is immunity?

- We are surronded by bacteria,viruses, and fungi, swarms on our skin and invades our inner passageways!!!
- **Immunity:** is the ability of organism to resist infection by any foreign (non-self) invaders

- **Function of immune system**

- Defends body against these small foreign invaders
- Tor distinguish between self (normal component of the body) and non-self (foreign component)s

What is ?

antibody

An **antibody** is a protein that binds specifically to a particular substance—its antigen. Each antibody molecule has a unique structure that enables it to bind specifically to its corresponding antigen, but all antibodies have the same overall structure and are known collectively as immunoglobulins or Igs. Antibodies are produced by plasma cells in response to infection or immunization, and bind to and neutralize pathogens or prepare them for uptake and destruction by phagocytes.

antigen

An **antigen** is any molecule that can bind specifically to an antibody. Their name arises from their ability to **gen**erate **anti**bodies. However, some antigens do not, by themselves, elicit antibody production; those antigens that can induce antibody production are called immunogens.

antigen receptors

T and B lymphocytes collectively bear on their surface highly diverse **antigen receptors** capable of recognizing a wide diversity of antigens. Each individual lymphocyte bears receptors of a single antigen specificity.

What is ?

lymphocytes

All adaptive immune responses are mediated by **lymphocytes**. Lymphocytes are a class of white blood cells that bear variable cell-surface receptors for antigen. These receptors are encoded in rearranging gene segments. There are two main classes of lymphocyte—B lymphocytes (B cells) and T lymphocytes (T cells)—which mediate humoral and cell-mediated immunity, respectively. Small lymphocytes have little cytoplasm and condensed nuclear chromatin; on antigen recognition, the cell enlarges to form a lymphoblast and then proliferates and differentiates into an antigen-specific effector cell.

T cells

T cells, or **T lymphocytes**, are a subset of lymphocytes defined by their development in the thymus and by heterodimeric receptors associated with the proteins of the CD3 complex. Most T cells have $\alpha:\beta$ heterodimeric receptors but $\gamma:\delta$ T cells have a $\gamma:\delta$ heterodimeric receptor.

What is ?

primary immune response

The **primary immune response** is the adaptive immune response to an initial exposure to antigen. **Primary immunization**, also known as priming, generates both the primary immune response and immunological memory.

immunological memory

When an antigen is encountered more than once, the adaptive immune response to each subsequent encounter is speedier and more effective, a crucial feature of protective immunity known as **immunological memory**. Immunological memory is specific for a particular antigen and is long-lived.

Macrophages

Macrophages are large mononuclear phagocytic cells important in innate immunity, in early non-adaptive phases of host defense, as antigen-presenting cells, and as effector cells in humoral and cell-mediated immunity. They are migratory cells deriving from bone marrow precursors and are found in most tissues of the body. They have a crucial role in host defense.

What is ?

secondary antibody response

A **secondary antibody response** is the antibody response induced by a second or booster injection of antigen—a **secondary immunization**. The secondary response starts sooner after antigen injection, reaches higher levels, is of higher affinity than the primary response, and is dominated by IgG antibodies. Therefore, the response to each immunization is increasingly intense, so the secondary, tertiary, and subsequent responses are of increasing magnitude.

Neutrophils

Neutrophils, also known as **neutrophilic polymorphonuclear leukocytes**, are the major class of white blood cell in human peripheral blood. They have a multilobed nucleus and neutrophilic granules. Neutrophils are phagocytes and have an important role in engulfing and killing extracellular pathogens.

immunoglobulin

any of several classes of structurally related proteins that function as antibodies or receptors and a refound in plasma and other body fluids and in the membrane of certain cell.
Compare IgA, IgD, IgE,IgG, IgM.

Dendritic cells (DCs)

They named for their probing, 'tree-like' or dendritic shapes, are responsible for the initiation of adaptive immune responses and hence function as the 'sentinels' of the immune system.

macropinocytosis

Dendritic cells are unique in being able to carry out **macropinocytosis**, a process in which large amounts of extracellular fluid are taken up in single vesicles. This is one means of antigen uptake.

immunogen

An immunogen is a specific type of antigen that is able to elicit an immune response. Antibody development is dependent on a humoral immune response mediated by immune cells recognizing a molecule as being foreign. Injecting an immunogen in the presence of an adjuvant pushes the immune system of the host to elicit a specific immune response, generating antibodies against the target

adjuvant

An adjuvant is a substance that is co-injected with antigen in order to help stimulate and enhance the adaptive immune system into producing antibodies against the antigen.

Natural Killer (NK) Cells

They are lymphocytes in the same family as T and B cells, coming from a common progenitor. However, as cells of the innate immune system, NK cells are classified as group I Innate Lymphocytes (ILCs) and respond quickly to a wide variety of pathological challenges. NK cells are best known for killing virally infected cells, and detecting and controlling early signs of cancer. As well as protecting against disease, specialized NK cells are also found in the placenta and may play an important role in pregnancy.

Cells of the innate immune system

Phagocytes: neutrophils, macrophages,

Granulocytes: eosinophils, basophils, neutrophil

Others: dendritic cells

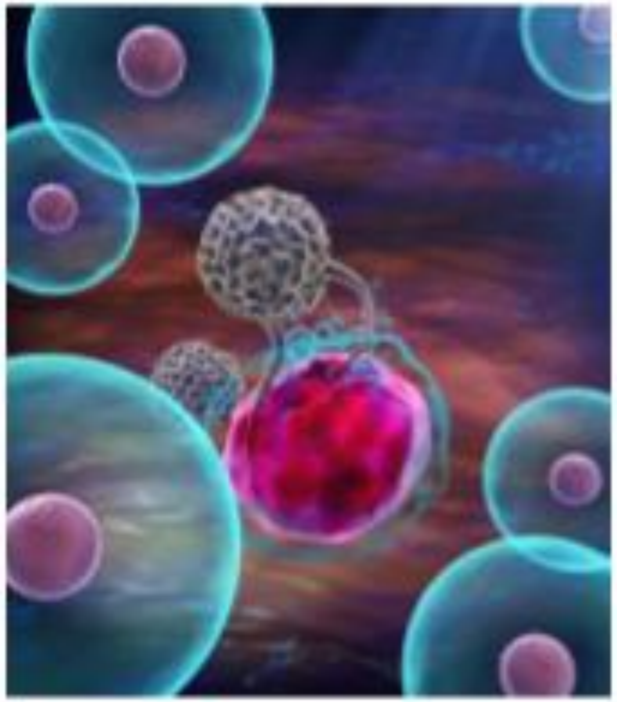
Lymphocytes

Natural killer cells

Natural killer T cells

Innate lymphoid cells

Platelets

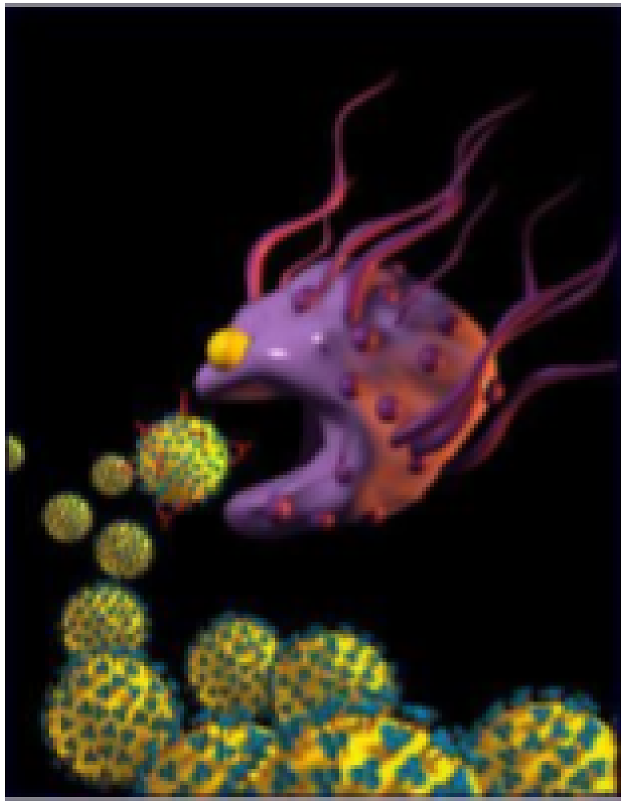


Phagocytes

The main phagocytes are neutrophils and macrophages.

Neutrophils circulate in the blood and the macrophages reside in tissues

There are many other types of phagocytic cells in the liver, brain etc…



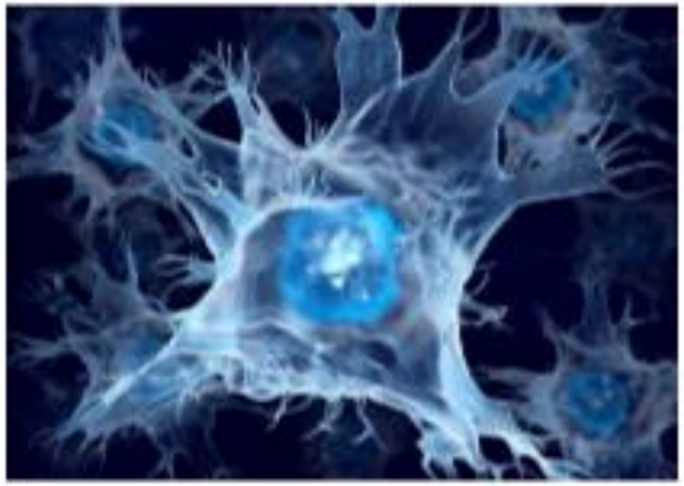
Dendritic cells

- the most important antigen presenting cells

- play a major role in presenting antigen to T cells and activating them

- They are the main link between the innate and the adaptive immune system

- are widely distributed in lymphoid tissue, mucosal epithelium and in organs.



Mast cells

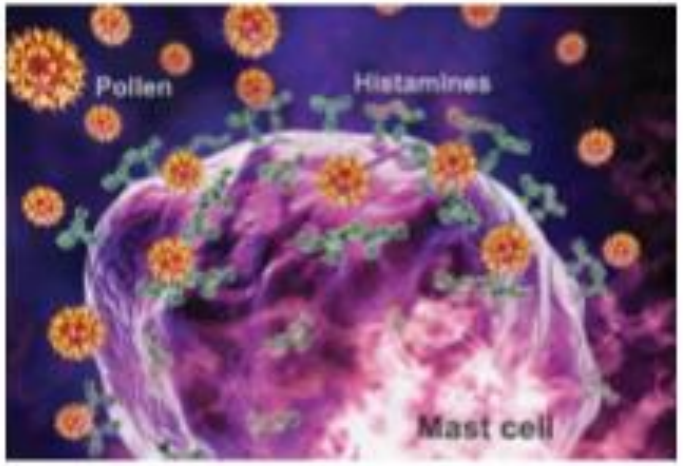
Are found adjacent to small blood vessels in tissues.

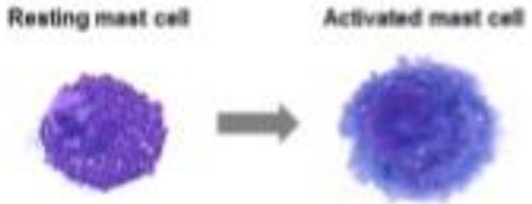
Have receptors with high affinity for IgE antibodies

Become activated when antigen binds to surface IgE

Can also be activated directly by certain chemicals

Play a major role in allergic responses



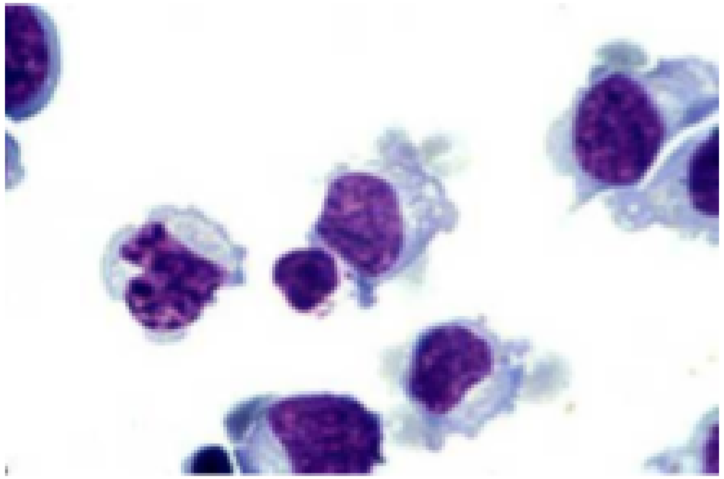


Natural killer cells

Are a subset of lymphocytes that can kill target cells without prior activation.

They represent 5-12% of the circulating lymphocytes.

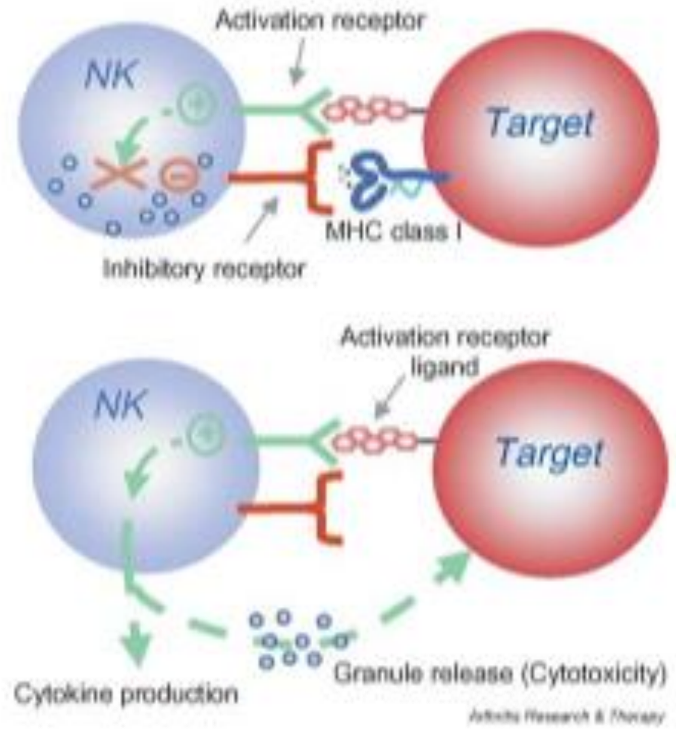
Important for defense against viruses, intracellular microorganisms and tumors



Natural killer cells

Have activating and inhibitor receptors. When receptors are engaged the NK cells are not activated because the signals are balanced.

If the inhibitory signals are missing (down regulation of MHC class I molecules) or if there is an over expression of activating signals the NK cells are activated.



Killer immunoglobulin-like recepto on the surface of NK cells (KIRs) and MHC class-I molecules when they are triggered by a negative signal, the killing of the target cell is prevented.

NK cells contribute to host defence by their ability to rapidly secrete cytokines and chemokines, as well as to directly kill infected host cells. NK cells respond to the absence of class-I MHC molecules. NK cells can be targeted to IgG antiboy coated cells by Fc receptors. In addition to their participation in the immediate innate immune response against infection, interactions between NK cells and dendritic cells shape the nature of the subsequent adaptive immune response to pathogens and also play an important role on pathogenesis and prognosis of autoimmune disease.

Why Antigens Are Not Necessarily Immunogens

While all immunogens are antigens, not all antigens are immunogens. This is because some antigens are too small or difficult to bind to be easily detected by the immune system, subsequently preventing macrophages from collecting the antigen and activating B-cells. Without the activation of B-cells to produce specific antibodies that recognize the foreign antigen, there will be no humoral response. If this is the case, the antigen is not an immunogen. In contrast, immunogenic antigens are able to elicit a humoral immune response and have antibodies generated against it, leading to antibody development.

The Purpose of Adjuvants

immunizing with only antigen prevents a strong immune response of high antibody titers, and shortening the time required for affinity maturation of high antibody affinity. To prevent this undesired immune response, adjuvant is mixed with antigen before immunization, delaying immediate antigen removal from the immune system and making adjuvants a necessary part of antibody development.

The Four Ways Adjuvants Work

1. Activate Antigen Presenting Cells to Show T Cells That Foreign Particles Are Present

Adjuvants increase recruitment and activation of antigen presenting cells (APCs). APCS are immune cells that engulf foreign particles, digest them into small fragments, and then present the fragments to T cells. Once activated T cells, activate the B cells that produce antibodies.

2. Inducing Release of Cytokines that Activate T Cells

Adjuvants can indirectly activate T cells by releasing complexes called phagosomes, which bind to T cells. The T cells then release cytokines that activate B cells to produce antibodies. This effect enhances the degree of antibody production against the foreign antigen that has entered the animal.

3. Targeting Antigens to Specific Locations

Adjuvants can induce an immune reaction to antigens at specific locations in an organism where the adjuvant was injected. Adjuvants activate the innate immune locally, which draws T cells that are circulating in the blood stream to that location.

4. Slow-Release of the Antigen

Adjuvants can control the rate at which antigens are released into the blood stream. This is called the depot effect. The adjuvant and antigen are trapped in a polymer, which slows the rate at which the chemicals and antigens leach into the surrounding tissue and into the circulatory system.

The Six Common types of Adjuvants

Mineral Salts

Aluminum salt is a common adjuvant. It is good at inducing a Th2 immune response, but is less effective for inducing a Th1 response. The Th2 response results in B cells producing antibodies that neutralize the antigen. The Th1 response results in B cells that produce antibodies that opsonize, or cling to, antigens so that other immune cells can recognize and kill things that are coated with antibodies.

Oil Emulsions

Mixtures of oil and water induce strong immune reactions. They are good at inducing a Th2 immune response. They are also good for creating the slow-release effect of antigen depots.

Microbial Products

Sugars from the cell wall of microbes are foreign particles to animals. These polysaccharide chains can induce a severe immune reaction, due to the evolutionary arms race that has been going on between microbes and animals.

Saponins

Saponins are steroid molecules that have sugar chains attached to them. They naturally occur in plants and some microbes. Their advantage is that a low dose can trigger a intense immune response.

Synthetic Products

These molecules bind to and activate the PRR and TLR receptors in immune cells. These receptors send signals to the nucleus that cause the activation of genes that tell the cell to sound the alarm of infection to its neighbors.

Cytokines

Interferons (IFN) and interleukins (IL) are naturally occurring chemicals that are released by immune cells in order to activate each other. Specific types of these molecules can elicit distinct responses in immune cells.

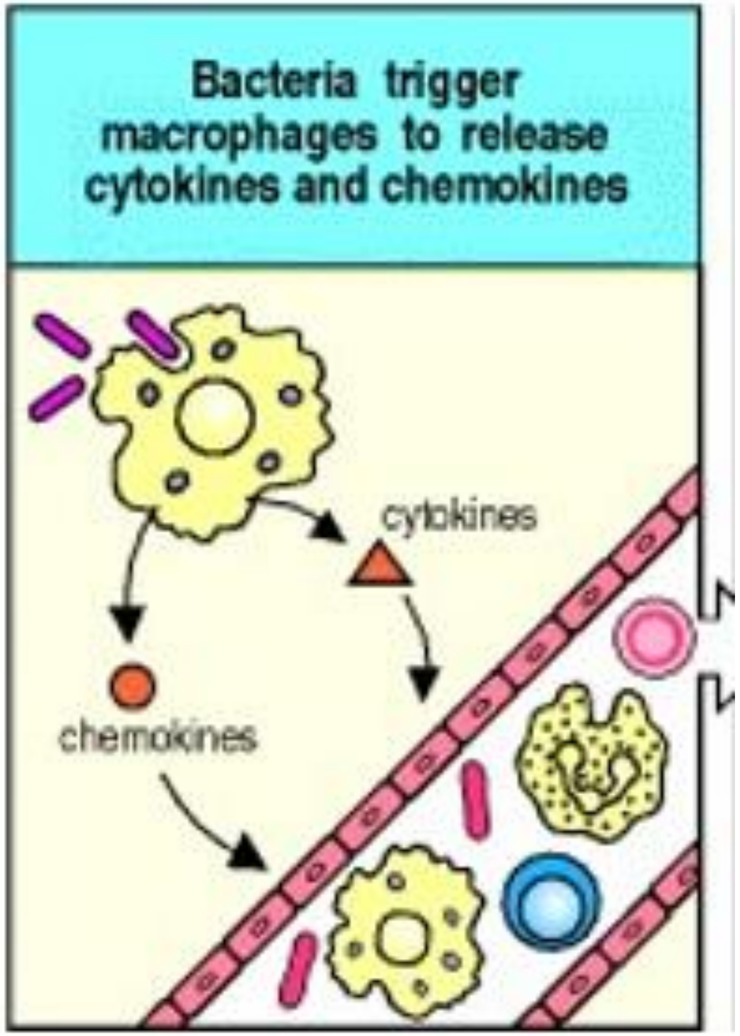
T lymphocytes are a major source of cytokines. These cells bear antigen specific receptors on their cell surface to allow recognition of foreign pathogens. They can also recognise normal tissue during episodes of autoimmune diseases. There are two main subsets of T lymphocytes, distinguished by the presence of cell surface molecules known as CD4 and CD8. T lymphocytes expressing CD4 are also known as helper T cells, and these are regarded as being the most prolific cytokine producers. This subset can be further subdivided into Th1 and Th2, and the cytokines they produce are known as Th1-type cytokines and Th2-type cytokines.

Principles of innate and adaptive immunity

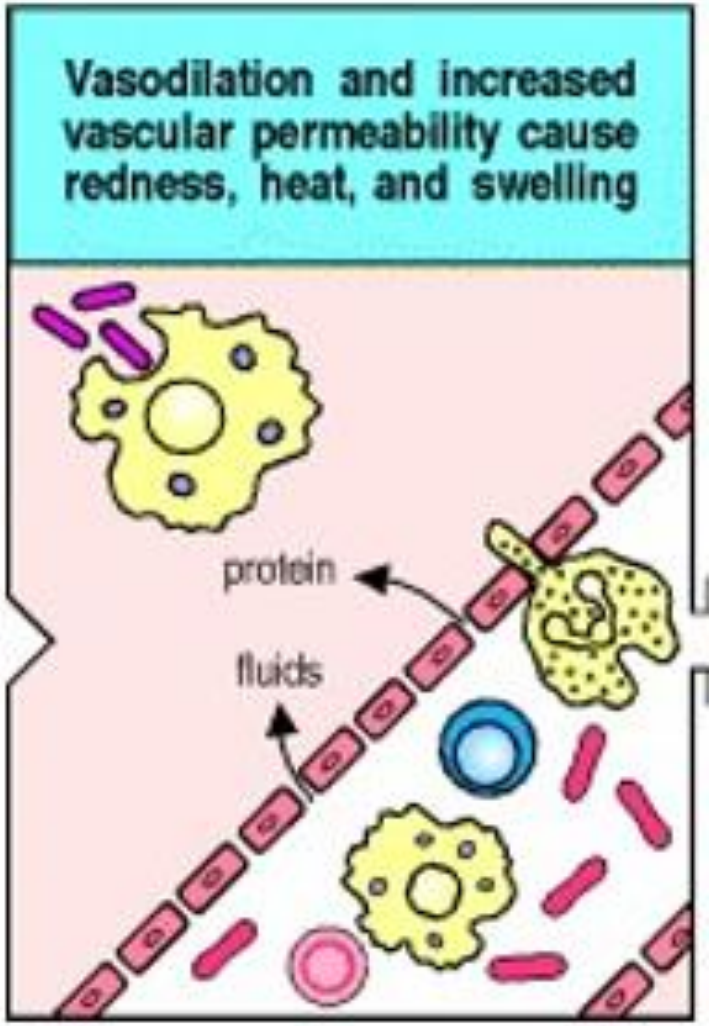
The macrophages and neutrophils of the innate immune system provide a first line of defense against many common microorganisms and are essential for the control of common bacterial infections. However, they cannot always eliminate infectious organisms, and there are some pathogens that they cannot recognize. The lymphocytes of the adaptive immune system have evolved to provide a more versatile means of defense which, in addition, provides increased protection against subsequent reinfection with the same pathogen.

Principles of innate and adaptive immunity

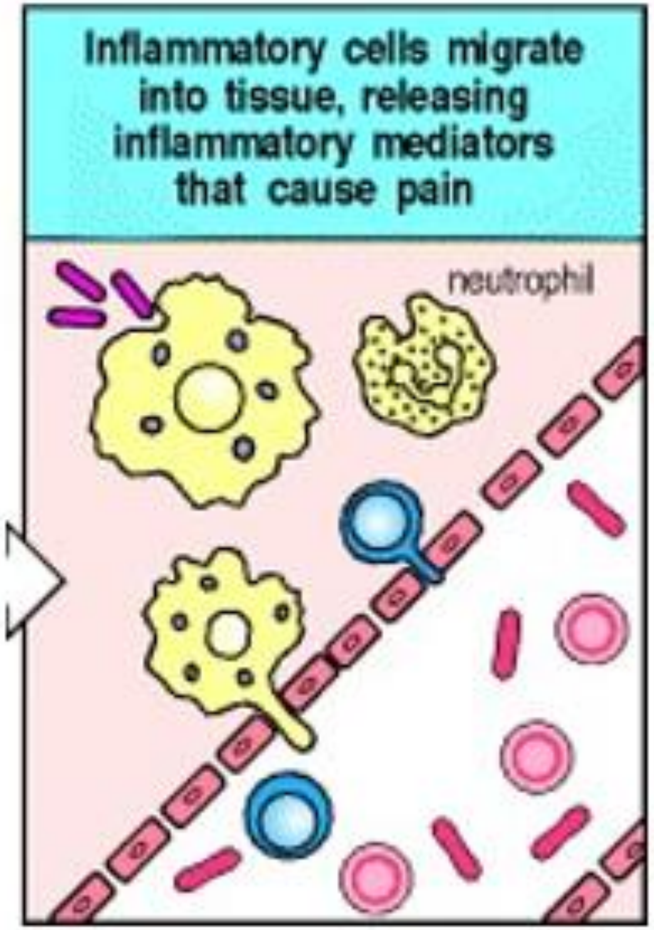
The cells of the innate immune system, however, play a crucial part in the initiation and subsequent direction of adaptive immune responses, as well as participating in the removal of pathogens that have been targeted by an adaptive immune response. Moreover, because there is a delay of 4–7 days before the initial adaptive immune response takes effect, the innate immune response has a critical role in controlling infections during this period.



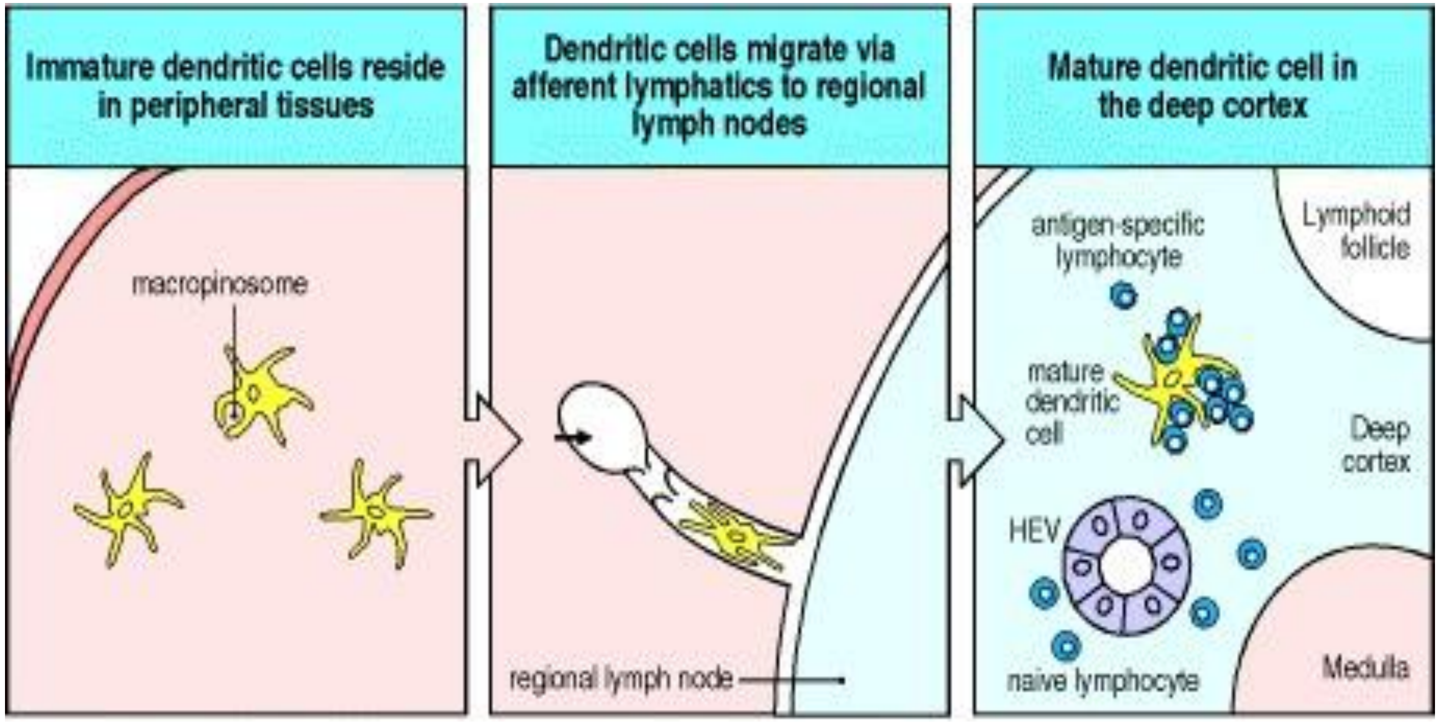
Macrophages encountering **bacteria** in the tissues are triggered to release cytokines that increase the permeability of blood vessels, allowing fluid and proteins to pass into the tissues. They also produce chemokines that direct the migration of neutrophils to the site of infection.



The stickiness of the endothelial cells of the blood vessels is also changed, so that cells adhere to the blood vessel wall and are able to crawl through it; first neutrophils and then monocytes are shown entering the tissue from a blood vessel.



The accumulation of fluid and cells at the site of infection causes the redness, swelling, heat, and pain, known collectively as inflammation. Neutrophils and macrophages are the principal inflammatory cells.



Immature dendritic cells resident in infected tissues take up pathogens and their antigens by macropinocytosis and receptor-mediated phagocytosis. They are stimulated by recognition of the presence of pathogens to migrate via the lymphatics to regional lymph nodes, where they arrive as fully mature nonphagocytic dendritic cells.

Here the mature dendritic cell encounters and activates antigen-specific naive T lymphocytes, which enter lymph nodes from the blood via a specialized vessel known from its cuboidal endothelial cells as a high endothelial venule.

The function of dendritic cells, however, is not primarily to destroy pathogens but to carry pathogen antigens to peripheral lymphoid organs and there present them to T lymphocytes.

The induction of an adaptive immune response begins when a pathogen is ingested by an immature dendritic cell in the infected tissue. Eventually, all tissue-resident dendritic cells migrate through the lymph to the regional lymph nodes where they interact with recirculating naive lymphocytes. If the dendritic cells fail to be activated, they induce tolerance to the antigens of self that they bear. The immature dendritic cell carries receptors on its surface that recognize common features of many pathogens, such as bacterial cell wall proteoglycans. As with macrophages and neutrophils, binding of a bacterium to these receptors stimulates the dendritic cell to engulf the pathogen and degrade it intracellularly. Immature dendritic cells are also continually taking up extracellular material, including any virus particles or bacteria that may be present, by the receptor-independent mechanism of macropinocytosis.

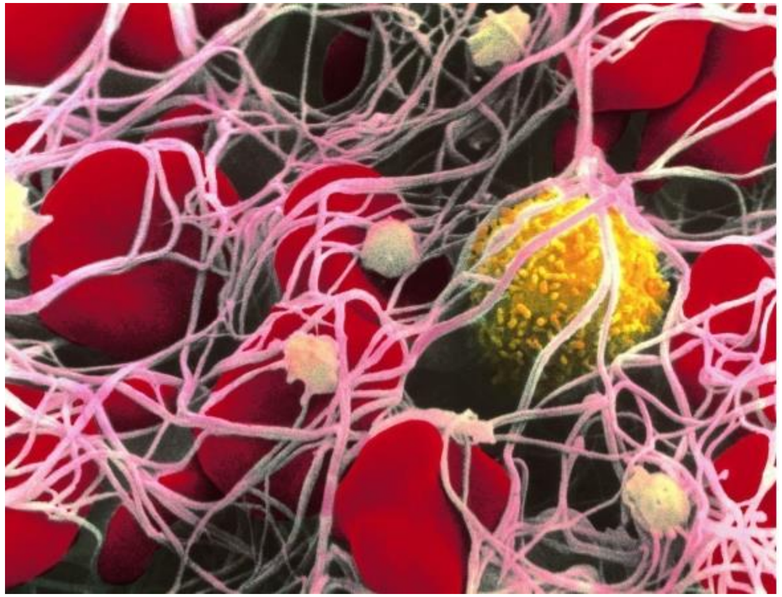
When a dendritic cell takes up a pathogen in infected tissue, it becomes activated, and travels to a nearby lymph node. On activation, the dendritic cell matures into a highly effective **antigen-presenting cell (APC**) and undergoes changes that enable it to activate pathogen-specific lymphocytes that it encounters in the lymph node. Activated dendritic cells secrete cytokines that influence both innate and adaptive immune responses, making these cells essential gatekeepers that determine whether and how the immune system responds to the presence of infectious agents.

First line of defence

- Non-specific defenses are designed to prevent infections by viruses and bacteria. These include:
  - Intact skin
  - Mucus and Cilia

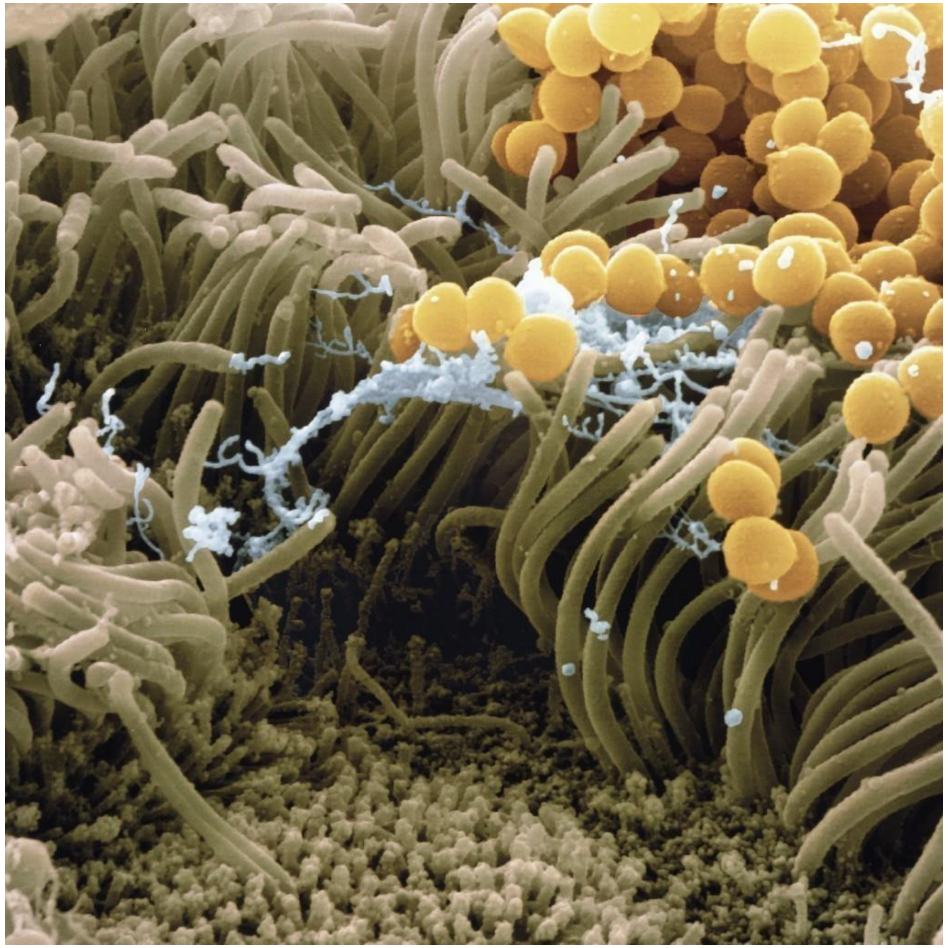
Role of skin

- Dead skin cells are constantly sloughed off, making it hard for invading bacteria to colonize.
- Sweat and oils contain anti-microbial chemicals, including some antibiotics.



Role of mucus and cilia

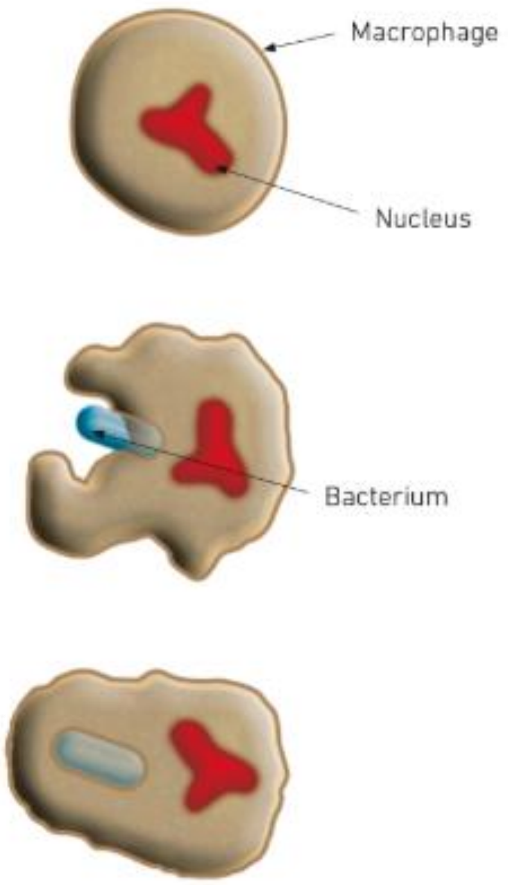
- Mucus contains lysozymes, enzymes that destroy bacterial cell walls.
- The normal flow of mucus washes bacteria and viruses off of mucus membranes.
- Cilia in the respiratory tract move mucus out of the lungs to keep bacteria and viruses out.



Staphylococcus aureus bacteria (yellow) sticking to the mucus (blue) on the hair-like cilia.

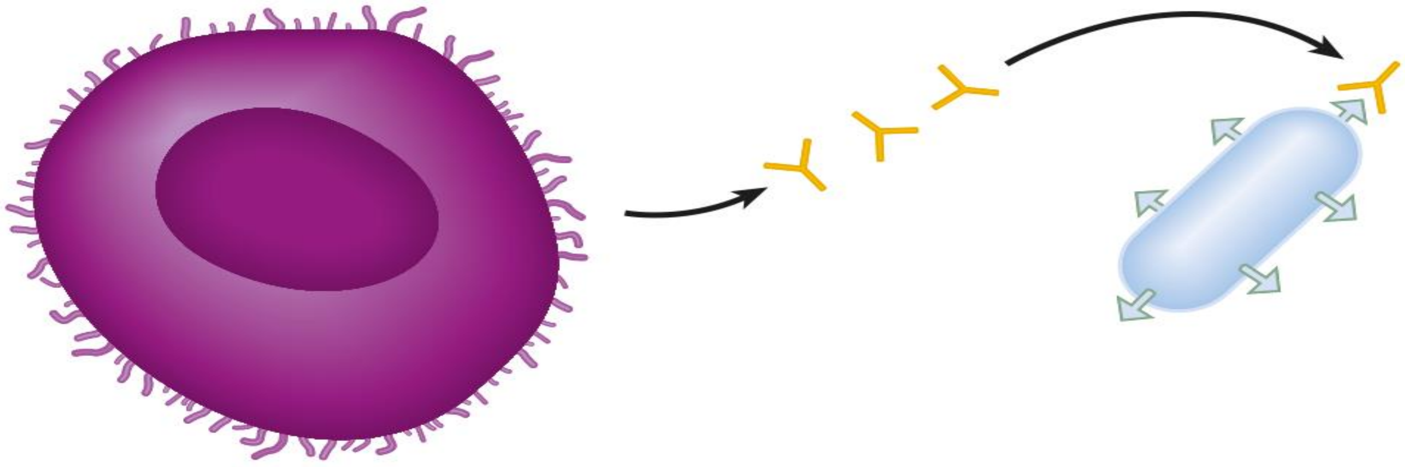
Second Line defences
Role of phagocytes

- Phagocytes are several types of white blood cells (including macrophages and neutrophils) that seek and destroy invaders. Some also destroy damaged body cells.
- Phagocytes are attracted by an inflammatory response of damaged cells.



The third line of defence

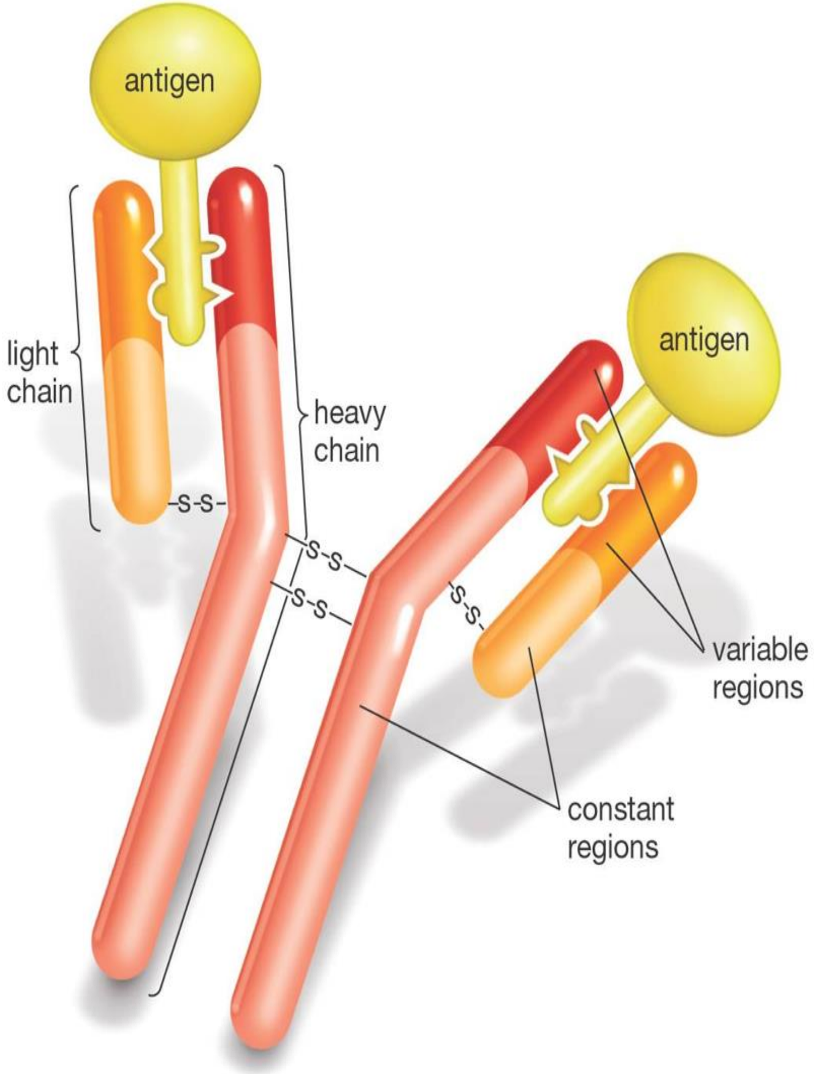
Antibody-antigen complex

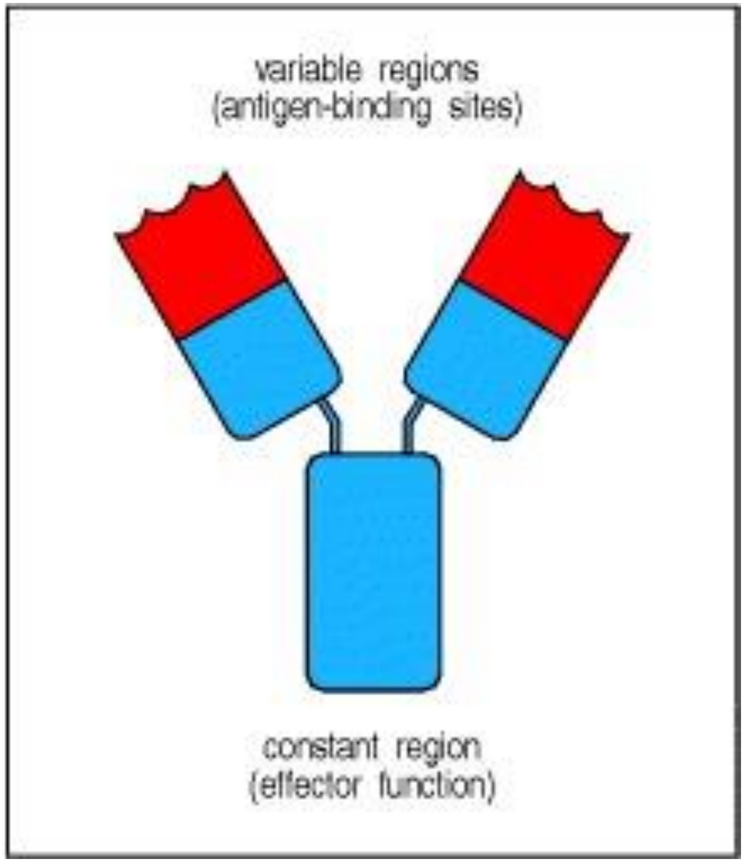


The third and final line of defence is the immune response. The invading microbe or pathogen is called an antigen. It is regarded as a threat by the immune system and is capable of stimulating an immune response.

Antibodies

- Antibody is a large Y-shaped protein an immunoglobulin (Ig)
- They are secreted form of the B-cell receptor
- The antibody recognizes a unique part of the antigen – epitope(a portion of a molecule to which an antibody binds) or antigenic determinants.

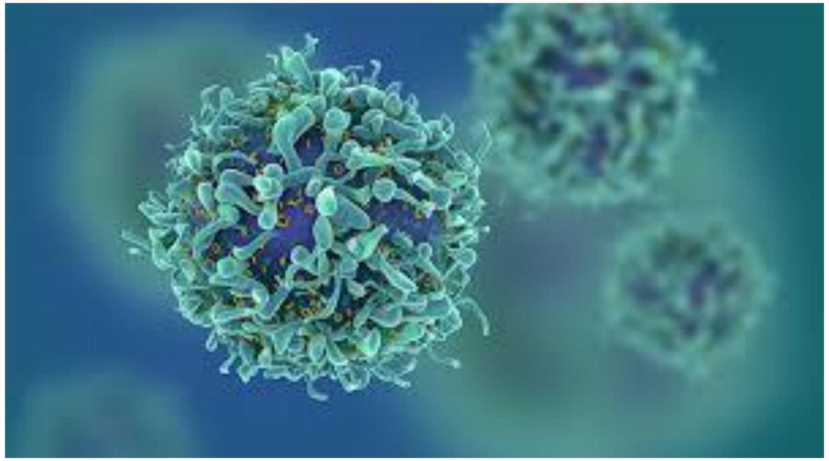




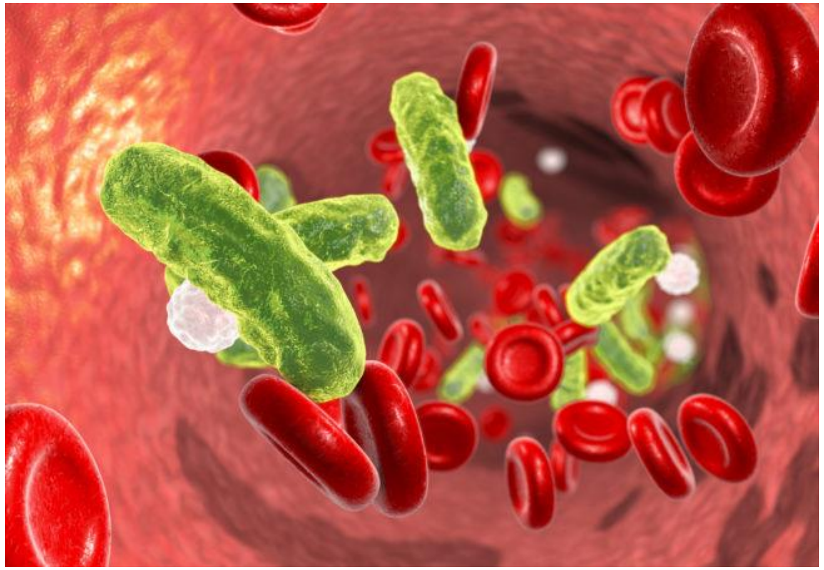
The two arms of the Y-shaped antibody molecule contain the variable regions that form the two identical antigen-binding sites. The stem can take one of only a limited number of forms and is known as the constant region. It is the region that engages the effector mechanisms that antibodies activate to eliminate pathogens.

The antibody is depicted as a Y-shaped molecule, with the constant region shown in blue and the variable region in red. The two variable regions, which are identical in any one antibody molecule, determine the antigen-binding specificity of the antibody; the constant region determines how the antibody disposes of the pathogen once it is bound.

Why do we have an immune system?



Cancer



Infection

The immune system is important to cancer patients in many ways because:

- cancer can weaken the immune system
- cancer treatments may weaken the immune system
- the immune system may help to fight cancer

Cancer and treatments may weaken immunity

Cancer can weaken the immune system by spreading into the bone marrow. The bone marrow makes blood cells that help to fight infection. This happens most often in leukaemia or lymphoma, but it can happen with other cancers too. The cancer can stop the bone marrow from making so many blood cells.

Certain cancer treatments can temporarily weaken the immune system. This is because they can cause a drop in the number of white blood cells made in the bone marrow.

Cancer treatments that are more likely to weaken the immune system are:

- **chemotherapy**
- **targeted cancer drugs**
- **radiotherapy**
- **high dose of steroids**

The immune system can help to fight cancer

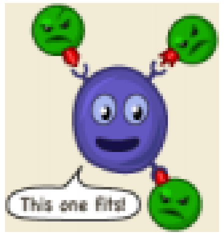
Some cells of the immune system can recognise cancer cells as abnormal and kill them. Unfortunately, this may not be enough to get rid of a cancer altogether. But some new treatments aim to use the immune system to fight cancer.

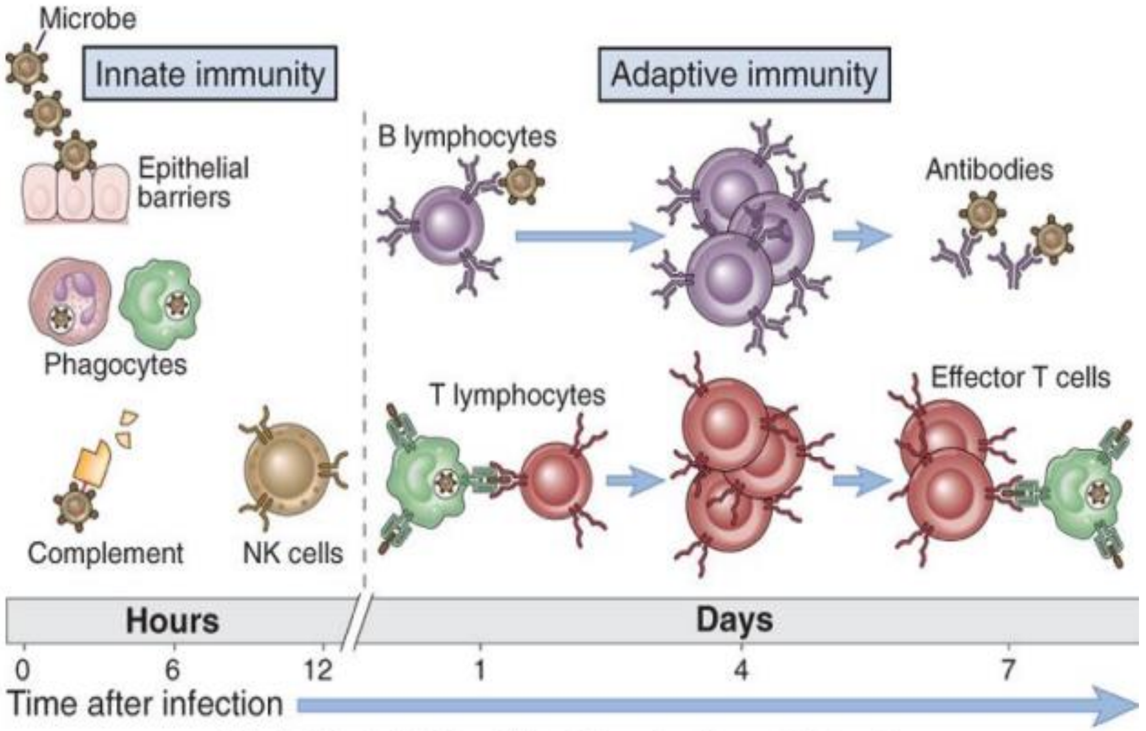
There are 2 main parts of the immune system:

•the protection we have from birth (in built immune protection)

•the protection we develop after having certain diseases (acquired immunity)

The immune response

Innate immunity	Adaptive immunity
Initial defense	Develops later.
React only to microbes and products of injured cells	Has the ability to 'remember'
React in the same way to repeated infections	Can react to a larger number of antigens
 	Can distinguish against different, even closely related microbes and molecules.



Components of the innate immune system

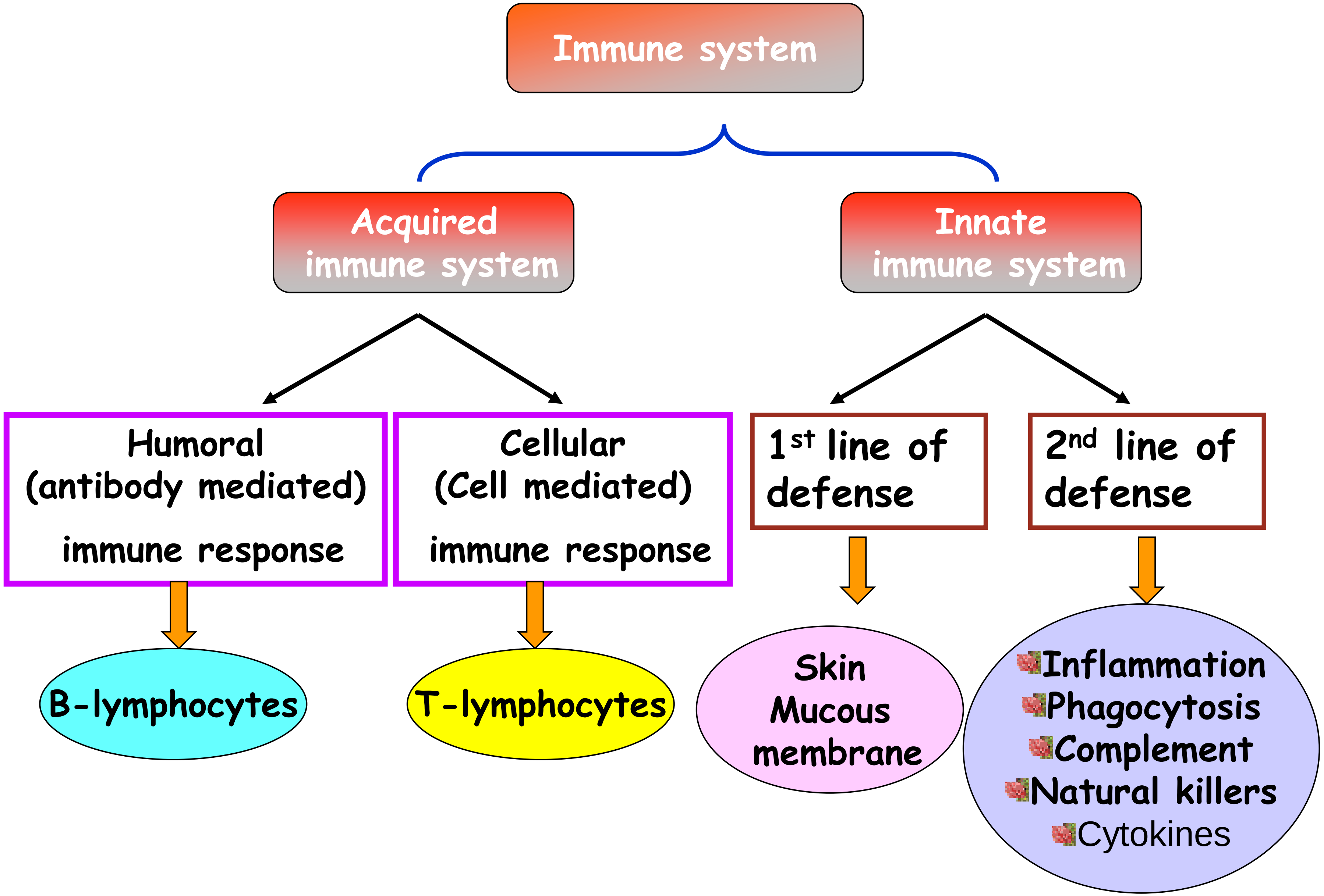
- Barriers: skin, mucosal membranes
- Flushing mechanisms
- Antimicrobial peptides: defensins and cathelidins
- Circulating and tissue resident effector cells: phagocytes, innate like lymphoid cells, mast cells, eosinophils, basophils, dendritic cells
- Circulating effector proteins: acute phase proteins, complement
- Cytokines: interferons

Main functions of the innate immune system

1. Initial response to microbes: Prevents controls and eliminates infection. All invertebrates only have an innate immune system

2. Eliminate of damaged cells and initiate tissue repair

3. Stimulates the adaptive immune system and influences the type of adaptive immune response that develops in response to infection and damage


Immune system
Acquired immune system
Innate immune system
Humoral (antibody mediated) immune response
Cellular (Cell mediated) immune response
1st line of defense
2nd line of defense
B-lymphocytes
T-lymphocytes
Skin
Mucous membrane
Inflammation
Phagocytosis
Complement
Natural killers
Cytokines

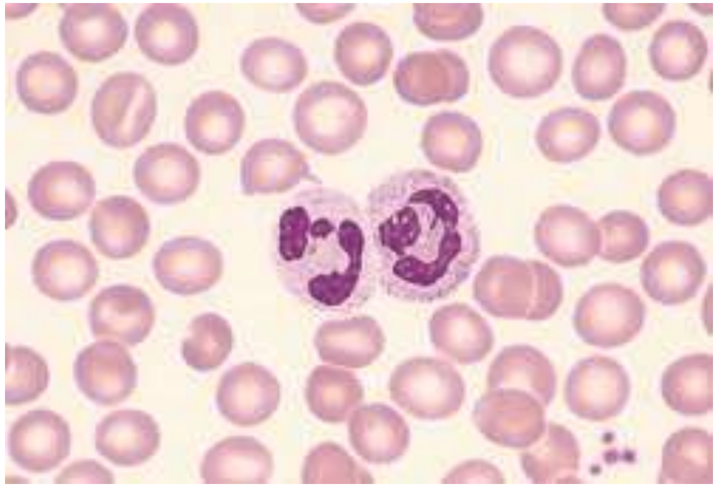
In built immune protection

This is also called innate immunity. These mechanisms are always ready and prepared to defend the body from infection. They can act immediately (or very quickly). This in built protection comes from:

- a barrier formed by the skin around the body
- the inner linings of the gut and lungs, which produce mucus and trap invading bacteria
- hairs that move the mucus and trapped bacteria out of the lungs
- stomach acid, which kills bacteria
- helpful bacteria growing in the bowel, which prevent other bacteria from taking over
- urine flow, which flushes bacteria out of the bladder and urethra
- white blood cells called neutrophils, which can find and kill bacteria

Certain cancer treatments can also overcome these protection mechanisms.

Neutrophils



These white blood cells are very important for fighting infection.
They can:

- move to areas of infection in the body
- stick to the invading bacteria, viruses or fungi
- swallow up the bacteria, viruses or fungi and kill them with chemicals

Your normal neutrophil count is between 2,000 and 7,500 per cubic millimetre of blood.

Why are you more likely to get bacterial or fungal infections after these treatments?

Acquired immunity

This is immune protection that the body learns after having certain diseases. The body learns to recognise each different kind of bacteria, fungus or virus it meets for the first time. So, the next time the same bug invades the body, the immune system is ready for it and able to fight it off more easily.

Vaccination works by using this type of immunity. A vaccine contains a small amount of protein from a disease. This is not harmful, but it allows the immune system to recognise the disease if it meets it again. The immune response can then stop you getting the disease.

Does a live vaccine cause an infection?

B cells and T cells

The bone marrow produces all blood cells, including B and T lymphocytes. Like the other blood cells, they have to fully mature before they can help in the immune response.

B cells mature in the bone marrow. But T cells mature in the thymus gland. Once they are fully mature, the B and T cells travel to the spleen and lymph nodes ready to fight infection.

Helper T cells

- Helper T-cells have receptors for recognizing antigens. If they are presented with an antigen, they release cytokines to stimulate B-cell division.
- The helper T-cell is the key cell to signal an immune response. If helper T-cells are disabled, as they are in people with AIDS, the immune system will not respond.

B cells

- B-cells in general produce antibodies. Those with antibodies that bind with the invader’s antigen are stimulated to reproduce rapidly.
- B-cells differentiate into either plasma cells or memory B-cells.
- Plasma cells rapidly produce antibodies. Memory cells retain the “memory” of the invader and remain ready to divide rapidly if an invasion occurs again.

Killer T cells

- While B-cells divide and differentiate, so do T-cells.
- Some T-cells become cytotoxic, or “killer” T-cells. These T-cells seek out and destroy any antigens in the system, and destroy microbes “tagged” by antibodies.
- Some cytotoxic T-cells can recognize and destroy cancer cells.

SUMMARY

The early innate systems of defense, which depend on invariant receptors recognizing common features of pathogens, are crucially important, but they are evaded or overcome by many pathogens and do not lead to immunological memory. The abilities to recognize all pathogens specifically and to provide enhanced protection against reinfection are the unique features of adaptive immunity.

İf the receptor on a lymphocyte is specific for a ubiquitous self antigen, the cell is eliminated by encountering the antigen early in its development, while survival signals received through the antigen receptor select and maintain a functional lymphocyte repertoire. Adaptive immunity is initiated when an innate immune response fails to eliminate a new infection, and antigen and activated antigen-presenting cells are delivered to the draining lymphoid tissues.

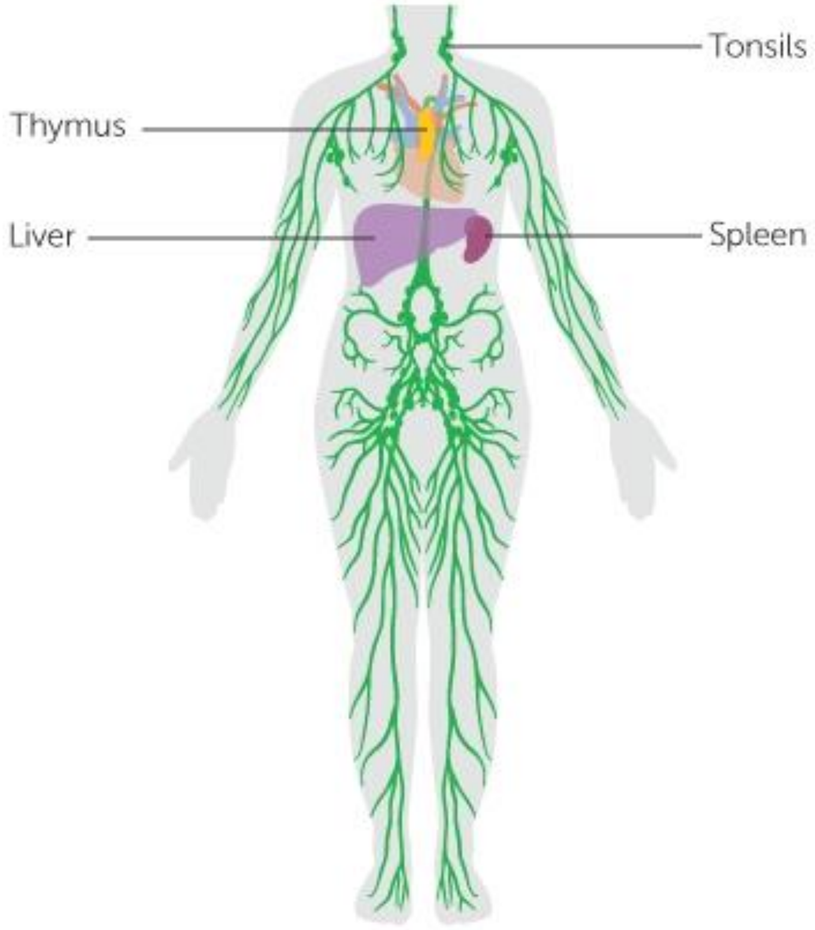
When a recirculating lymphocyte encounters its specific foreign antigen in peripheral lymphoid tissues, it is induced to proliferate and then differentiate into effector cells that can eliminate the infectious agent. A subset of these proliferating lymphocytes differentiate into memory cells, ready to respond rapidly to the same pathogen if it is encountered again

The immune system plays a huge role in protecting against infection and cancers

What the lymphatic system is

The lymphatic system is a system of thin tubes and lymph nodes that run throughout the body. These tubes are called lymph vessels or lymphatic vessels. The lymph system is an important part of our immune system. It plays a role in:

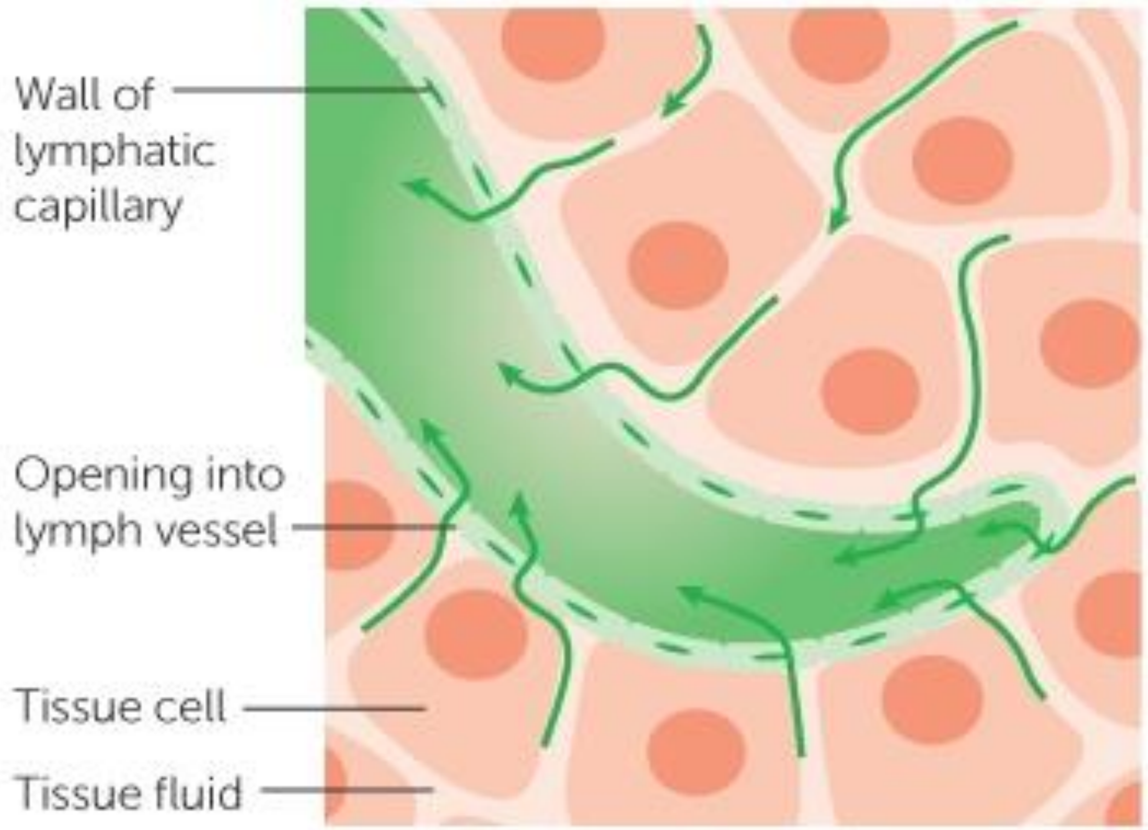
- fighting bacteria and other infections
- destroying old or abnormal cells, such as cancer cells



How it works

The lymphatic system is similar to the blood circulation. The lymph vessels branch through all parts of the body like the arteries and veins that carry blood. But the lymphatic system tubes are much finer and carry a colourless liquid called lymph.
The lymph contains a high number of a type of white blood cells called lymphocytes. These cells fight infection and destroy damaged or abnormal cells.

As the blood circulates around the body, fluid leaks out from the blood vessels into the body tissues. This fluid carries food to the cells and bathes the body tissues to form tissue fluid. The fluid then collects waste products, bacteria, and damaged cells. It also collects any cancer cells if these are present. This fluid then drains into the lymph vessels.



The lymph then flows through the lymph vessels into the lymph glands, which filter out any bacteria and damaged cells.
From the lymph glands, the lymph moves into larger lymphatic vessels that join up. These eventually reach a very large lymph vessel at the base of the neck called the thoracic duct. The thoracic duct then empties the lymph back into the blood circulation.

- **Primary Lymphoid organs of the immune system**
  I. Thymus
  II. bone marrow
- **Secondary lymphoid organs**
  I. Lymph nodes
  II. Spleen
  III. Skin
  IV. liver
  V. Tonsils
  VI. Small intestine

The thymus

The thymus is a small gland under your breast bone. It helps to produce white blood cells to fight infection. It is usually most active in teenagers and shrinks in adulthood

The spleen

The spleen is under your ribs, on the left side of your body. It has 2 main different types of tissue, red pulp and white pulp.

The red pulp filters worn out and damaged red blood cells from the blood and recycles them.

The white pulp contains many B lymphocytes and T lymphocytes. These are white blood cells that are very important for fighting infection. As blood passes through the spleen, these blood cells pick up on any sign of infection or illness and begin to fight it.

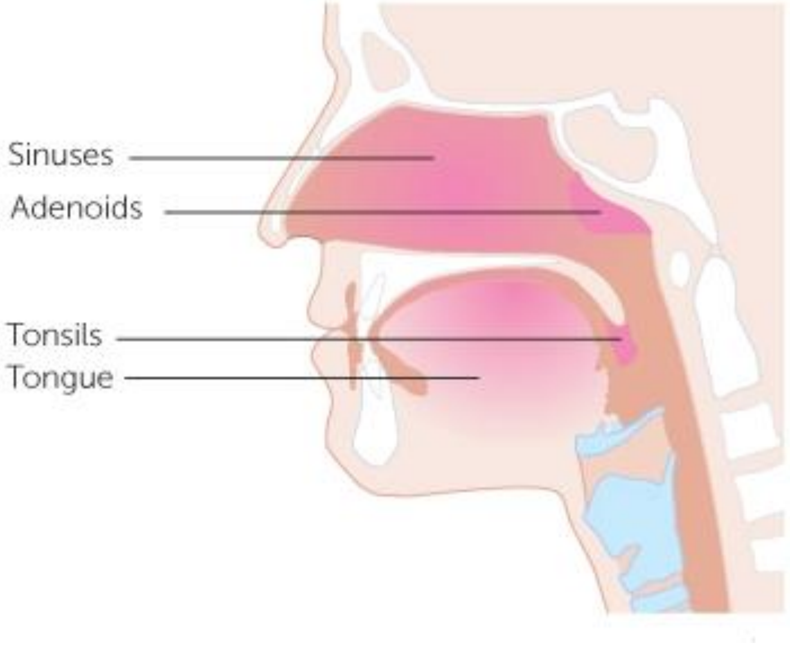
Lymph nodes (lymph glands)

The lymph glands are small bean shaped structures, also called lymph nodes.

There are lymph nodes in many parts of the body including:

under your arms, in your armpits
in each groin (at the top of your legs)
in your neck
in your tummy (abdomen)

The lymph nodes filter the lymph fluid as it passes through them. White blood cells, such as B cells and T cells, attack any bacteria or viruses they find in the lymph.



The tonsils and adenoids

The tonsils are 2 glands in the back of your throat.

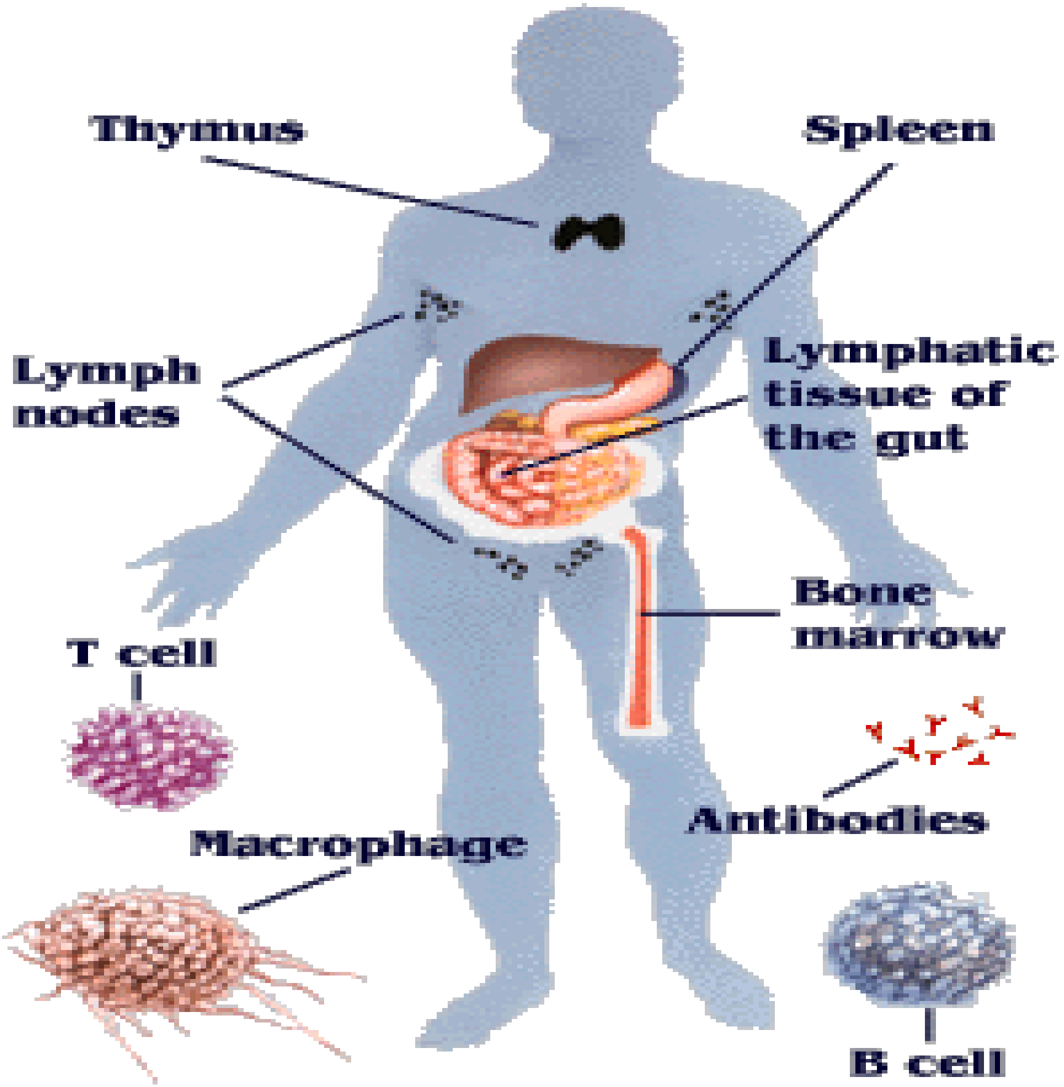
The adenoids are glands at the back of your nose, where it meets the back of your throat. The adenoids are also called the nasopharyngeal tonsils.

The tonsils and adenoids help to protect the entrance to the digestive system and the lungs from bacteria and viruses.

What B cells do

B cells react against invading bacteria or viruses by making proteins called antibodies. The antibody made is different for each different type of germ (bug). The antibody locks onto the surface of the invading bacteria or virus. The invader is then marked with the antibody so that the body knows it is dangerous and needs to be killed. Antibodies can also detect and kill damaged cells.

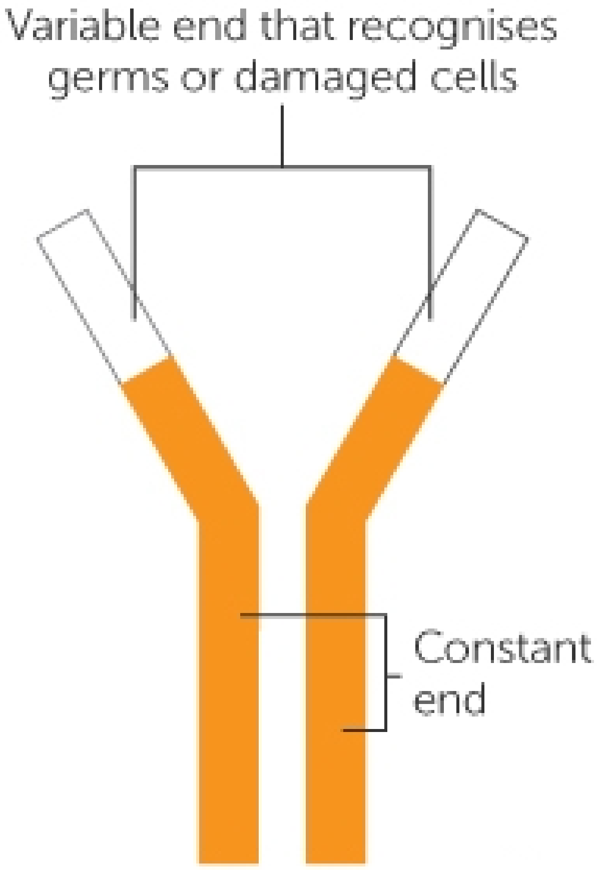
The B cells are part of the memory of the immune system. The next time the same germ tries to invade, the B cells that make the right antibody are ready for it. They are able to make their antibody very quickly.



How antibodies work

Antibodies have 2 ends. One end sticks t proteins on the outside of white blood cell The other end sticks to the germ or damage cell and helps to kill it. The end of th antibody that sticks to the white blood cell i always the same. Scientists call this th constant end.

The end of the antibody that recognise germs and damaged cells varies, dependin on the cell it needs to recognise. So it i called the variable end. Each B cell make antibodies with a different variable end fro other B cells.



Cancer cells are not normal cells. So some antibodies with variable ends recognise cancer cells and stick to them.

What T cells do

There are different kinds of T cells called:

- helper T cells
- killer T cells

The helper T cells stimulate the B cells to make antibodies and help killer cells develop.

Killer T cells kill the body's own cells that have been invaded by the viruses or bacteria. This prevents the germ from reproducing in the cell and then infecting other cells.

Cancer treatments that use the immune system

Some cancer treatments use elements of the immune system to help treat cancer.

Immunotherapy

Immunotherapy is a treatment for some types of cancer, for example melanoma that has spread. It uses natural body substances, or drugs made from natural body substances, to treat cancer.

They are helpful in cancer treatment because cancer cells are different from normal cells. And the immune system can recognise and kill abnormal cells.

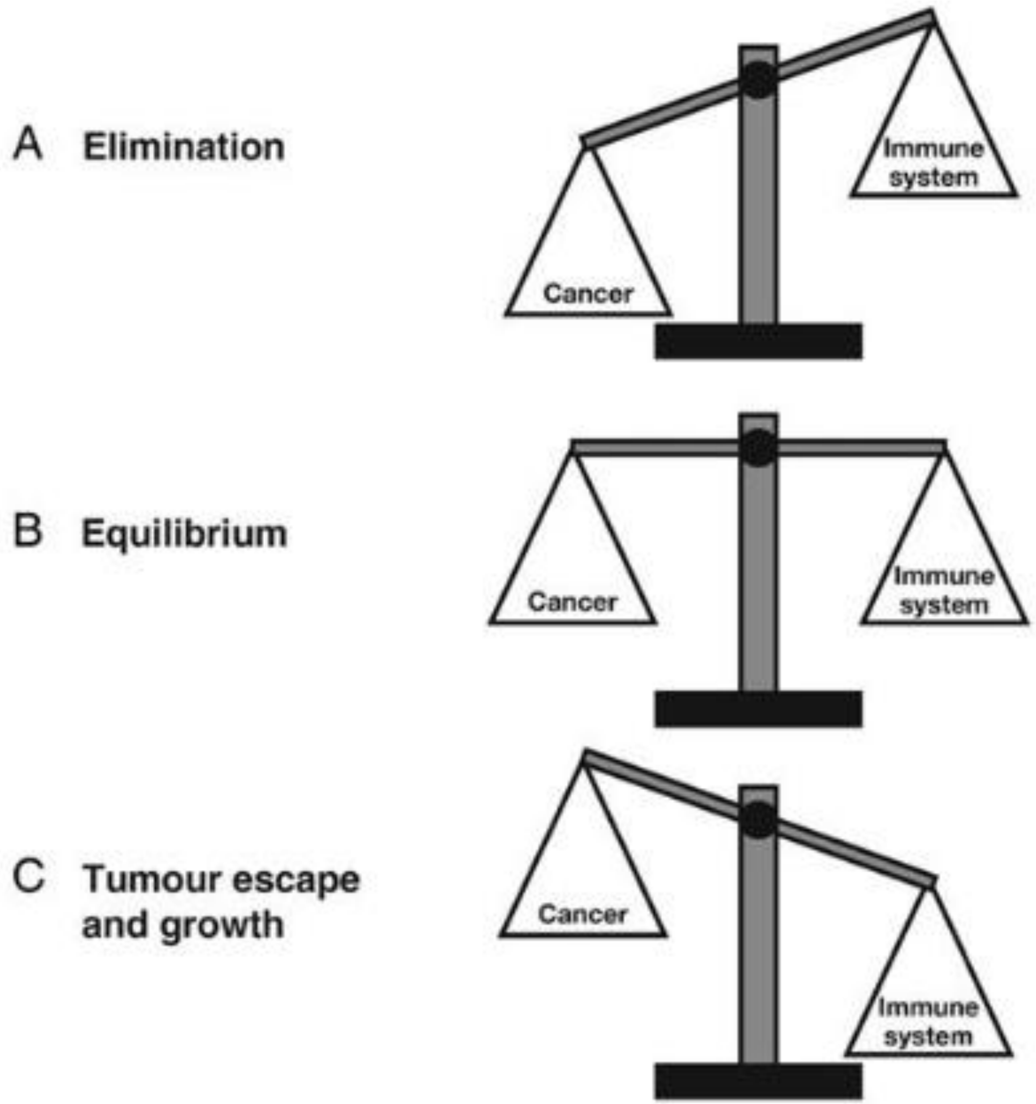
Scientists can produce, in the laboratory, different chemicals that are part of the immune response. So, they can make different types of immunotherapy such as:

- monoclonal antibodies (MABs), which recognise and attack certain proteins on the surface of cancer cells
- vaccines to help the immune system to recognise and attack cancer
- cytokines to help to boost the immune system
- adoptive cell transfer to change the genes in a person's white blood cells

Effects on cancer

- Cancer is a heterogeneous group of diseases with multiple causes, and immunological involvement varies across different cancers.
- The immune system has the greatest potential for the specific destruction of tumours with no toxicity to normal tissue and for long-term memory that can prevent cancer recurrence.
- In many cancers, however, malignant progression is accompanied by profound immune suppression that interferes with an effective antitumour response and tumour elimination.

In cancer patients, that the immune system can recognise and reject tumours. **Immunotherapy**, which involves strengthening the cancer patient's immune system by improving its ability to recognise the tumour or providing a missing immune effector function, is one treatment approach that holds promise of a life-long cure.



it is now recognised that in different individuals and with different cancers, the process can have at least three different but related outcomes:

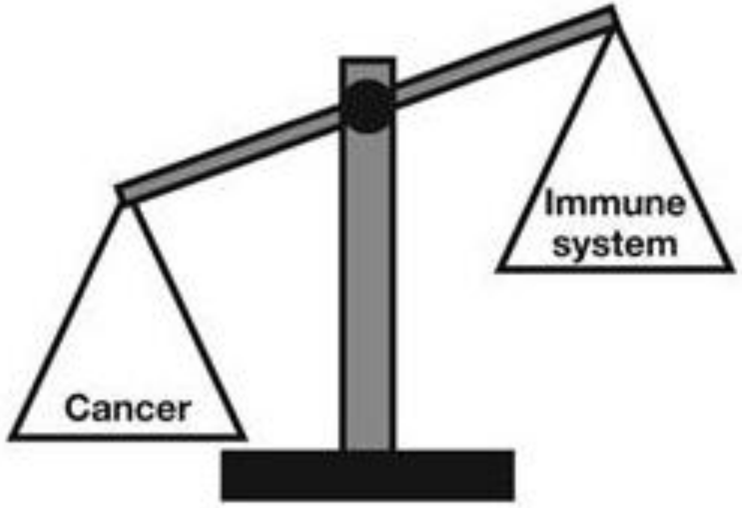
elimination,

equilibrium,

escape

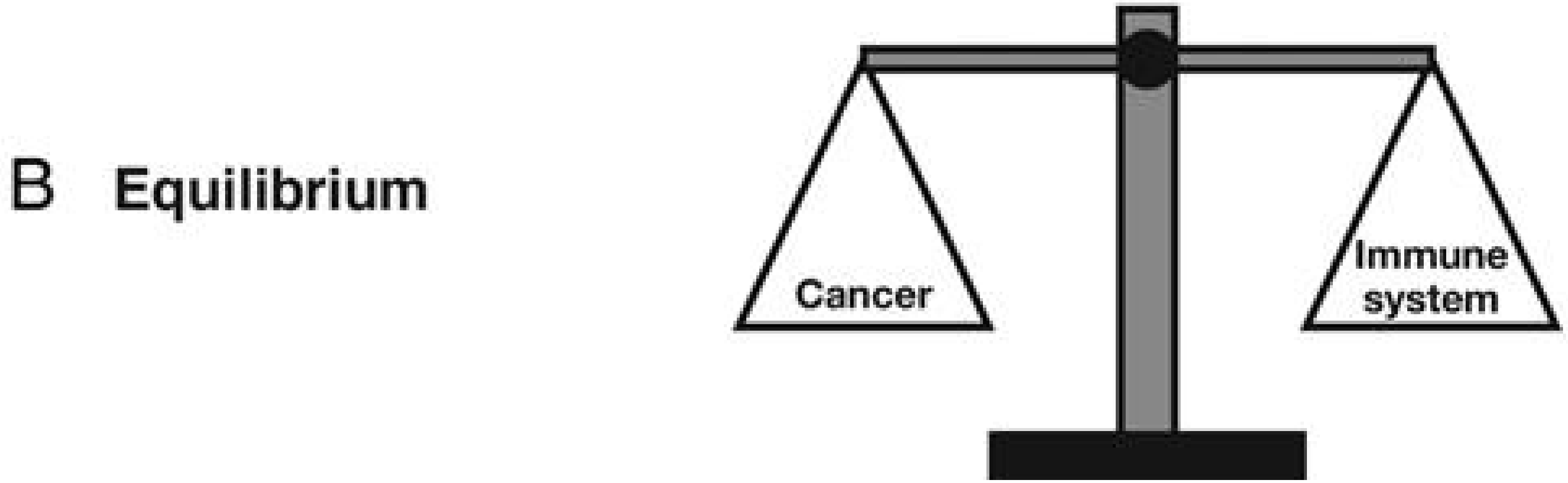
A highly immunogenic tumour in a highly immunocompetent individual will result in optimal stimulation of the innate immune system leading to the production of highly immunostimulatory cytokines, acute inflammation, activation of a large number of T- and B cells, and prompt elimination of the arising tumour.

A Elimination



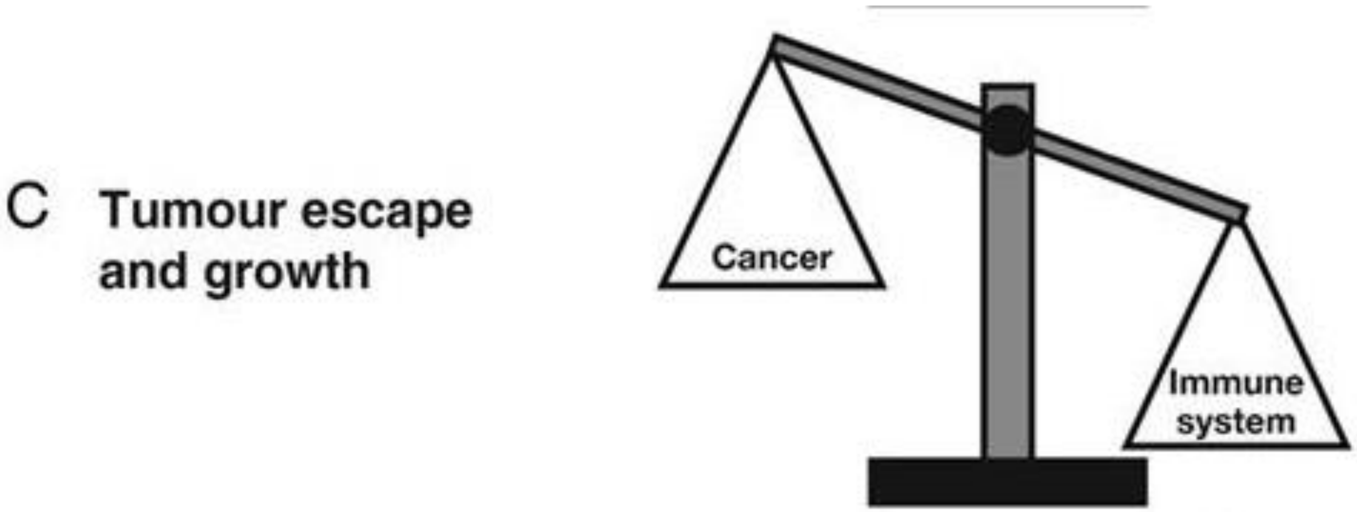
the immune system can specifically identify and eliminate tumour cells on the basis of their expression of specific antigens

Over a prolonged period of time, the slow growth of the tumour would be accompanied by repeated activation of the immune system and elimination of some tumour cells, followed by further cycles of tumour regrowth and immune-mediated destruction. This period, when the tumour is present but not yet a clinical disease, is known as equilibrium.



However, in cases where the immune system is not able to completely eliminate the cancer, a state of equilibrium develops whereby the tumour does not progress or further metastasize

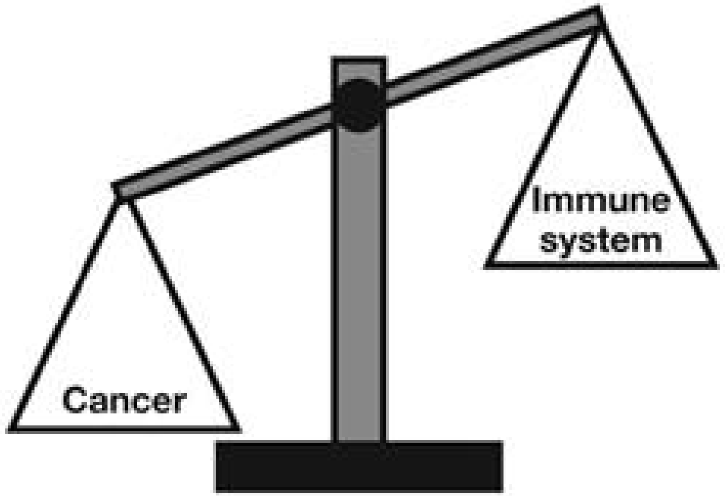
The equilibrium phase could be life-long, thus mimicking elimination, or be disturbed by changes in the tumour that allow it to avoid immunosurveillance or changes in the immune system that weaken its capacity for tumour surveillance. Either change ultimately leads to tumour escape



Eventually, if the immune response fails to completely eliminate the tumour, cancer cells that can resist, avoid, or suppress the antitumour immune response are selected, leading to the tumour escape and a progressively growing tumour

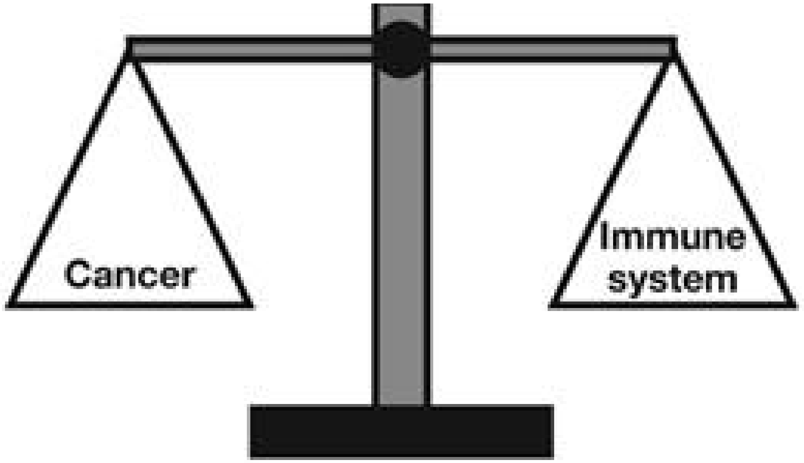
infiltration of tumours by inflammatory immune cells can result in a state of chronic inflammation that maintains and promotes cancer progression and suppresses the innate anticancer immune response

D . Increase in tumour–promoting immune cells



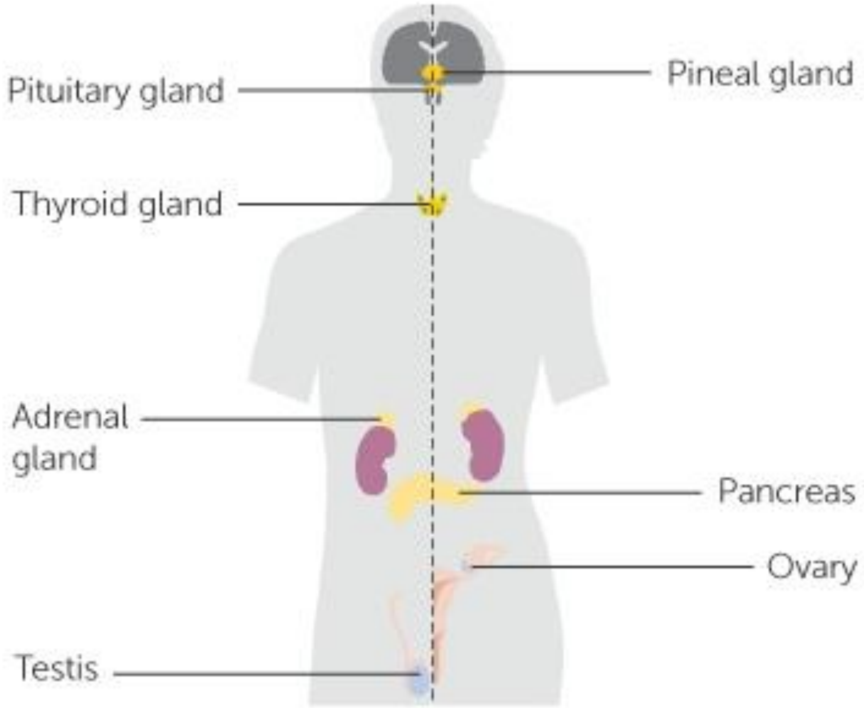
The aim of immunotherapy is to modulate tumour immunity to change the ongoing immune response from tumour-promoting to tumour-rejecting, thus providing durable and adaptable cancer control.

E Immunotherapy



The hormone system and Cancer

The hormone system is a network of glands and organs in the body that produce hormones. It is also called the endocrine system



Hormones and how they work

Hormones are natural substances made by the glands and organs of the hormone system. Our bloodstream carries the hormones around the body. Each gland makes a different hormone and most make more than one.

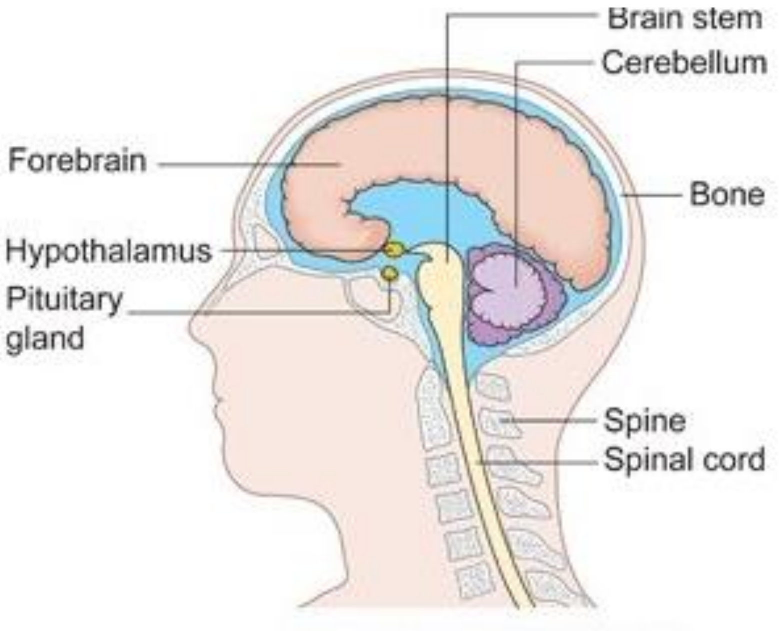
They act as chemical messengers between one part of the body and another.

Each hormone has a different purpose. They control how we respond to changes in the environment around us, as well as:

- growth and development
- how the body works
- our mood
- sexual function
- reproduction

glands → hormones → bloodstream.

hormones → gland → cells → receptor



The hypothalamus is part of the brain and not actually part of the endocrine system. It works with the pituitary gland to control the activity of the other glands.

When the level of a hormone drops, the hypothalamus signals to the pituitary gland. The pituitary then produces hormones, that tell other glands to produce the hormone that the body needs.

For example, the thyroid gland makes thyroid hormones. It only does this when the hypothalamus detects that the level of thyroid hormones is low. The hypothalamus signals to the pituitary gland to produce thyroid stimulating hormone (TSH). TSH then stimulates the thyroid to produce thyroid hormones. When the thyroid hormones are at the right level, the hypothalamus signals to the pituitary gland to stop producing TSH. The thyroid gland then stops making thyroid hormones. This is how the body controls hormone levels.

The pituitary gland

This is a small gland at the base of the brain. The pituitary makes a number of hormones and controls many different body functions. Many of the pituitary gland hormones signal to other parts of the hormone system to make, or stop making, other hormones.

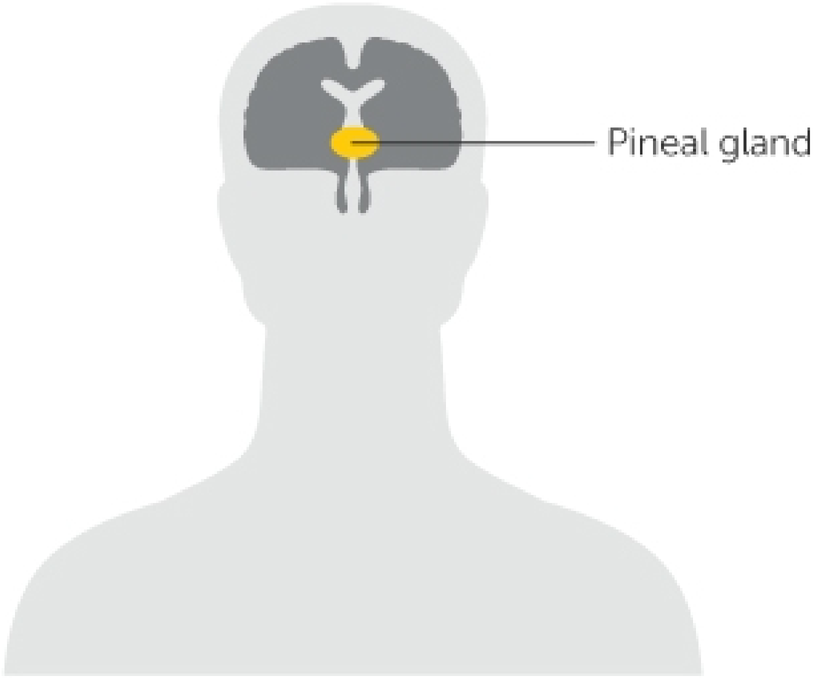
Pituitary hormones control:

- growth, by producing growth hormone
- the speed of body processes (metabolism), by producing thyroid stimulating hormones (TSH)
- steroid levels, by producing adrenocorticotropic hormone that tells the adrenal glands to make steroids
- breast milk production after birth by producing prolactin that makes the breasts produce milk

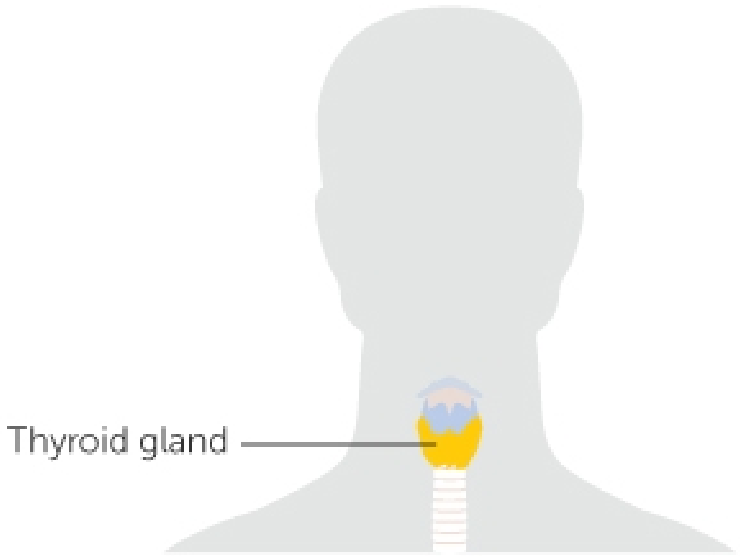
The pituitary gland also controls the egg production in women and the sperm production in men. It produces 2 hormones called follicle stimulating hormone (FSH) and luteinising hormone (LH). These control oestrogen and progesterone levels in women and testosterone levels in men. FSH and LH levels are in turn controlled by the hypothalamus.

The pineal gland

The pineal gland is a very small gland deep in the brain. It makes the hormone melatonin, which controls sleep patterns.

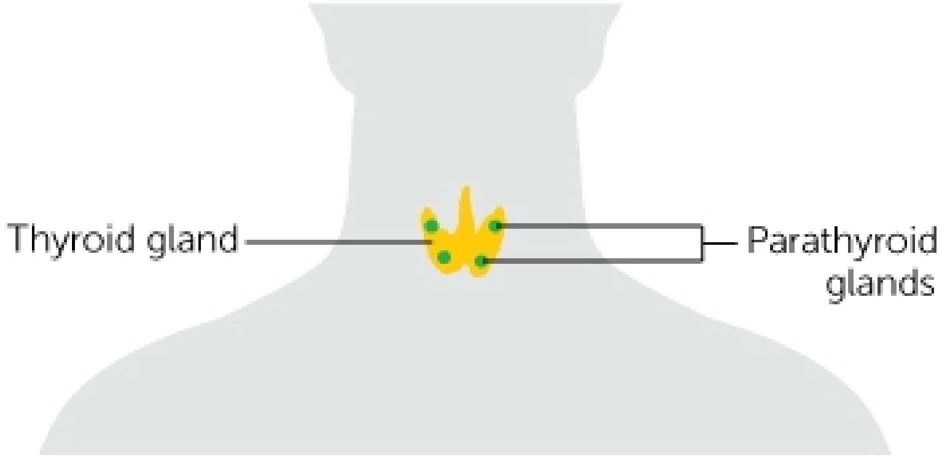


The thyroid and parathyroid glands



The thyroid makes these hormones:
•T3 which is also called tri iodothyronine
•T4 which is also called thyroxine
•calcitonin
The hormones T3 and T4 help to control how fast your body works. This is your metabolic rate. If your thyroid gland doesn't make enough of these hormones, you put on weight and feel very tired and lacking in energy. This is often called underactive thyroid.

You lose weight and have an increased appetite if your thyroid gland makes too much of the T3 and T4 hormones. This is an overactive thyroid. You may also feel anxious and find it difficult to relax.
Calcitonin helps to control the amount of calcium in the body.



The parathyroid glands are 4 very small glands next to the thyroid gland. They make parathyroid hormone (PTH).

Along with calcitonin and vitamin D, PTH controls the level of calcium in the blood.

The adrenal glands

The adrenal glands make several hormones. Cortisol is a natural steroid hormone that affects the level of sugar in the blood. Aldosterone helps to regulate the body's water and salt balance, and the blood pressure.

The adrenal glands also produce small amounts of the male and female sex hormones, oestrogen and testosterone.

Another important hormone made in the adrenal gland is adrenaline (epinephrine). Adrenaline helps us to respond quickly when under stress. Another similar hormone, noradrenaline (norepinephrine), also helps us to respond quickly under stress.