Infection and Disease

BIO101
LECTURE 10

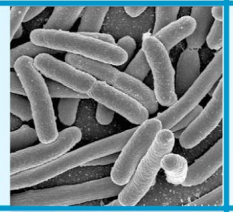
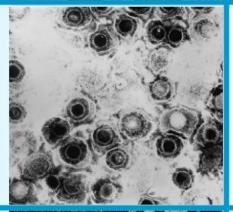
What is infection?

Infection is the invasion of a host organism’s bodily tissues by pathogens or infectious agents ,multiplication of pathogens and the reaction of host tissue against them.

Fungal infection
Bacterial infection

Pathogens

- A pathogen is a living thing that causes disease.
- Pathogenicity refers to the ability of a pathogenic agent to cause disease.

Type of pathogen	Description	Human diseases caused by pathogens of that type
Bacteria *Escherichia coli* 	Single-celled organisms without a nucleus	Strep throat, staph infections, tuberculosis, food poisoning, tetanus, pneumona, syphilis
Viruses *Herpes simplex* 	Non living particles that reproduce by taking over living cells	Common cold, flu, genital herpes, col sores, measle, AIDS, genital warts, chicken pox, small pox
Fungi *Death cap mushroom* 	Simple organisms, including mushrooms and yeasts, that grow as single cells or thread like filaments.	Ringworm, athlete's foot, tineas, candidiasis, histoplasmosis, mushroom poisoning
Protozoa *Giardia lamblia* 	Single-celled organism with a nucleus.	Malaria, "traveller's diarrhea" giardiasis, typano somiasis ("sleeping sickness")

Reservoir

Animals

Infectious diseases transmitted from animals to man are called zoonoses.

- Zoonotic diseases may be:
- Bacterial – bovine tuberculosis Viral- rabies from dogs
- Protozoal – Toxoplasmosis from cats
- Helminthic – Taeniasis from cattle
- Fungal- dermatophytes from dogs

Reservoir

c **Insects**

Diseases transmitted by insects are called arthropod-borne diseases.

Insects transmitting diseases are called vectors.

- **Mechanical vectors:** carry the organisms on their wings, legs, and body. Eg transmission of typhoid bacilli to man through food by domestic flies.
- **Biological vectors:** the pathogen multiplies in the body of the vector. E.g. female anopheles mosquito in malarial parasite.
- **Extrinsic incubation period:** after the entry of the pathogen in the vector the time required for the vector to become infective.

d. Soil and Water

- Some pathogens survive in the soil for long periods. E.g. spores of tetanus and gas gangrene bacilli, the fungus causing histoplasmosis, and parasites such as roundworm and hookworm.
- Contamination of water with vibrio cholera and hepatitis virus act as the source of infection.

Reservoir

Food

Contaminated food acts as a source of infection in the case of food poisoning, gastroenteritis, diarrhea, and dysentery.

Modes Of Transmission

i. Contact

a. Direct contact – directly through physical contact. STDs such as syphilis, gonorrhea, herpes simplex type 2, and AIDS.

b. Indirect contact- indirectly acquired through fomites.

ii. Airborne transmission:

a. Droplets of respiratory infection are spread by inhalation.

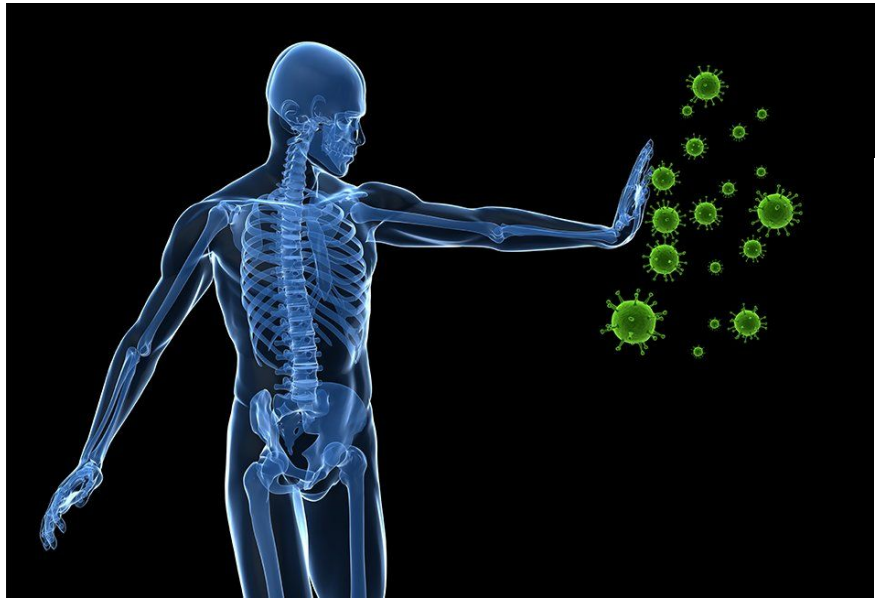
b. Droplet nuclei (1-10 micron diameter) remain airborne as aerosols act as a source of infection.

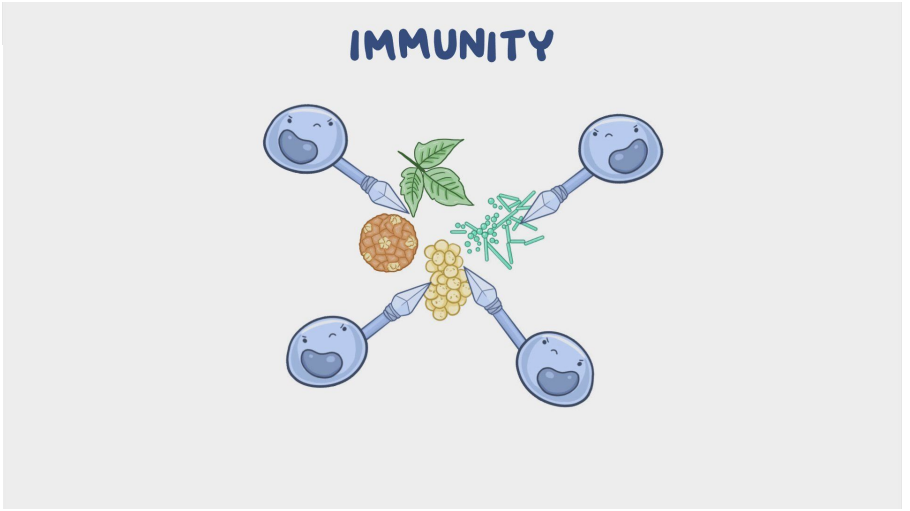
iii. Ingestion

Intestinal infections like cholera, dysentery, food poisoning, etc are acquired by ingestion of food or drink contaminated by pathogens.

Occurs mostly through carriers engaged in food handling or contaminated water supply.

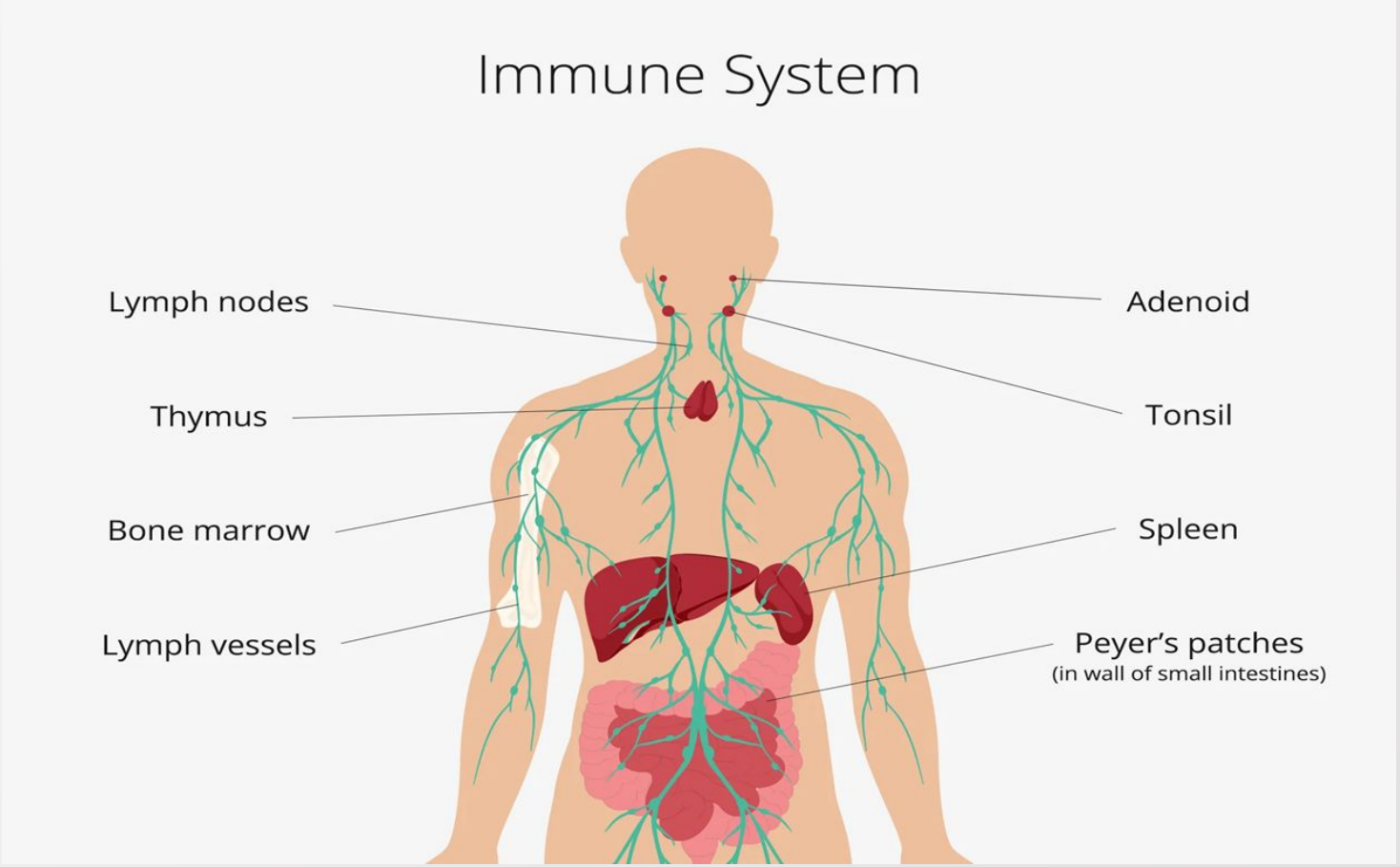
What if you can fight against disease-causing organisms ?





Immune system

Organs and tissues important to the proper functioning of the immune system include the thymus and bone marrow, lymph nodes and lymphatic vessels, spleen, and skin.

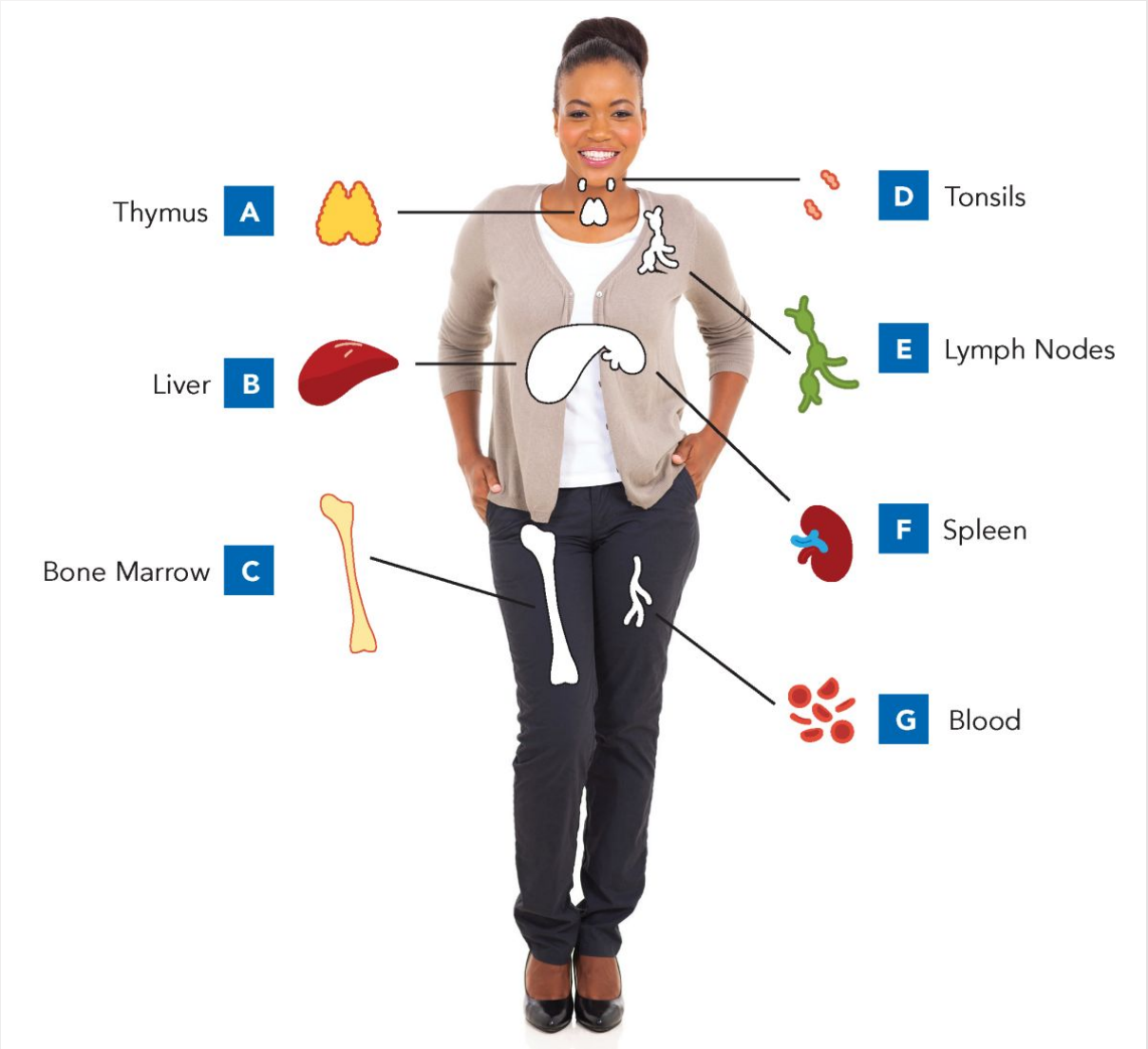


Immune system

- White blood cells circulate in the blood and lymphatic vessels.
- The lymphatic system forms a network similar to the blood circulation. It carries a substance called lymph instead of blood. Lymph is a fluid that carries immune-related cells to areas that need them.
- White blood cells work as a guard against pathogens. When they find germs, they begin to multiply and send signals to other cell types for defending.
- The body stores white blood cells in different places which are known as lymphoid organs.

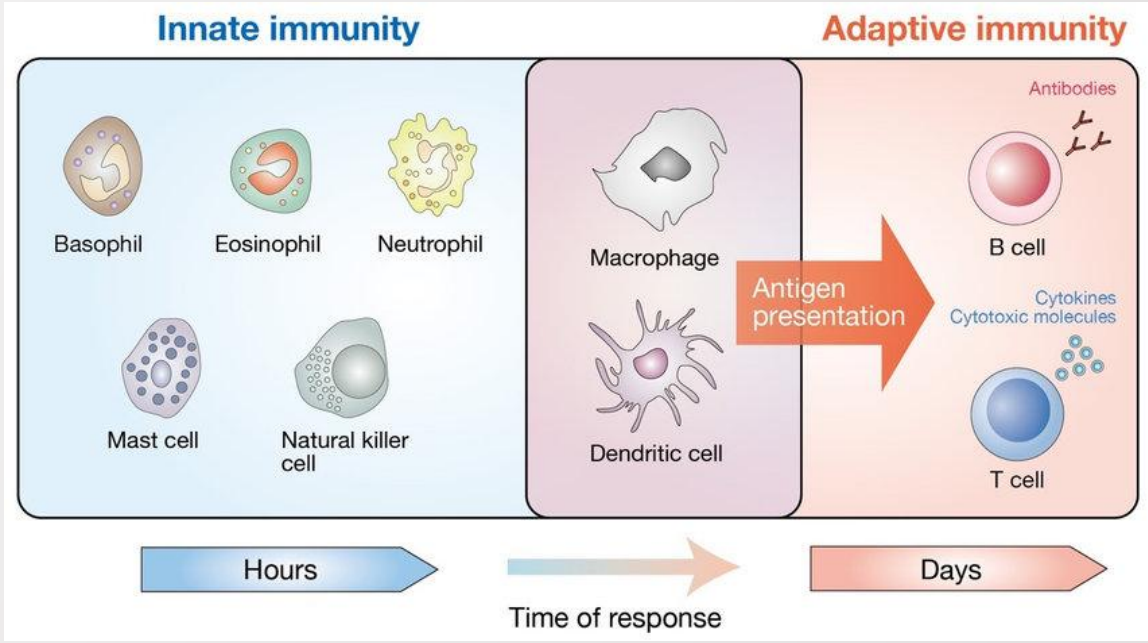
Major organs of immune system

Thymus: The thymus is an organ located in the upper chest where T cells mature. First, lymphocytes (a type of white blood cell) that are destined to become T cells leave the bone marrow and find their way to the thymus where they are then “educated” to become mature T cells.



Cellular components of the mammalian immune system

- The mammalian immune system consists of two distinct parts, innate and adaptive immunity.
- Basophils, eosinophils, neutrophils, mast cells, natural killer cells, macrophages, and dendritic cells mediate innate immunity. They provide the first line of defense against bacteria, viruses, and cancer.
- The adaptive immune system refers to an antigen-specific defense mechanism that takes several days to develop but provides long-lasting protection. The adaptive immune system includes B-cell-mediated humoral immunity and T-cell-mediated cellular immunity, both of which are directed toward specific antigens.
- Macrophages and dendritic cells are unique subsets that have both innate and adaptive immune cell traits. As professional antigen-presenting cells, macrophages and dendritic cells are critical in the induction of adaptive immunity by presenting the antigens to antigen-specific T and B lymphocytes.



How does immune system work particularly?

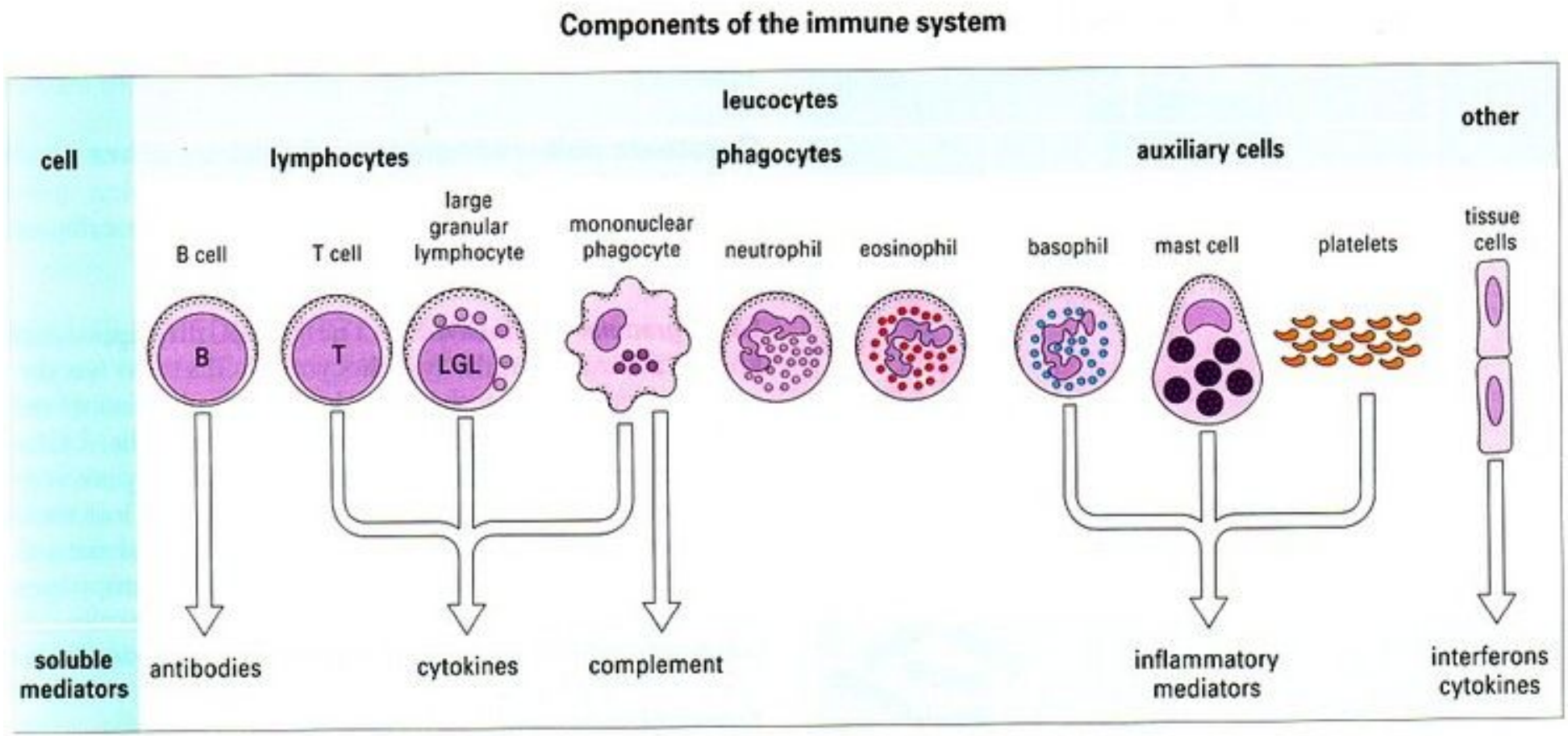
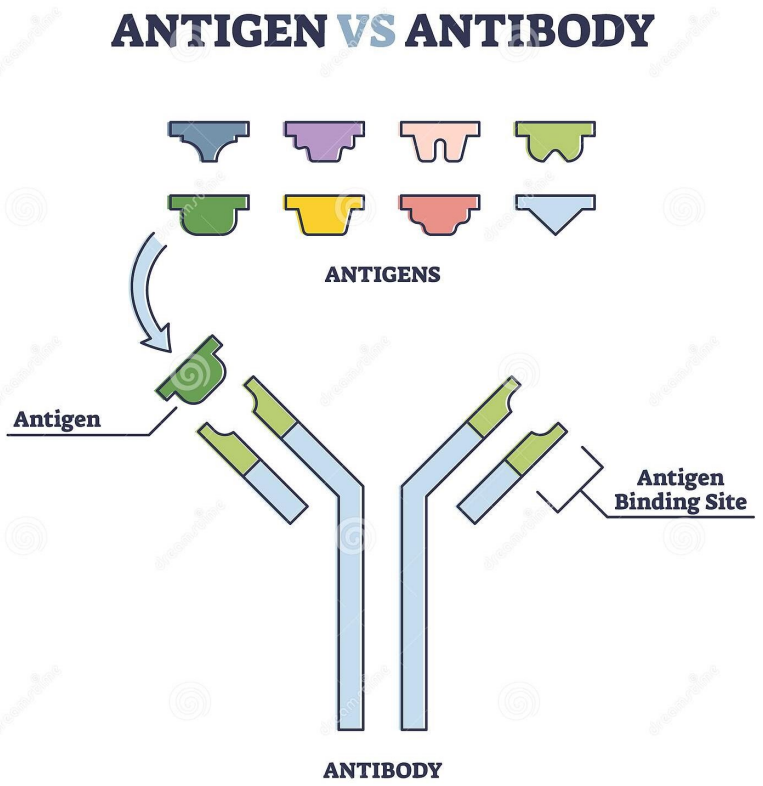
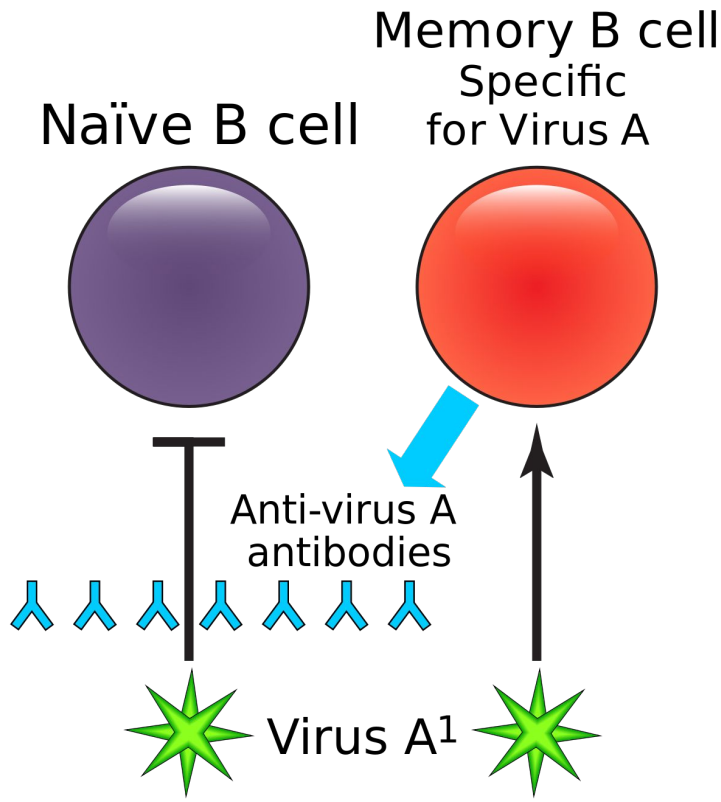


Fig. 1.4 The principal components of the immune system are shown, indicating which cells produce which soluble mediators. Complement is made primarily by the liver, although there is some synthesis by mononuclear phagocytes. Note that each cell produces and secretes only a particular set of cytokines or inflammatory mediators.

How do antibodies work?

- **An antigen** is unwanted foreign substance that enters our body. Foreign substances can include bacteria, viruses, fungi, allergens, venom, and other various toxins and disease-causing organisms.
- **An antibody** is a protein produced by our immune system to attack and fight off these antigens. Immunoglobulin is used as another word for antibody.

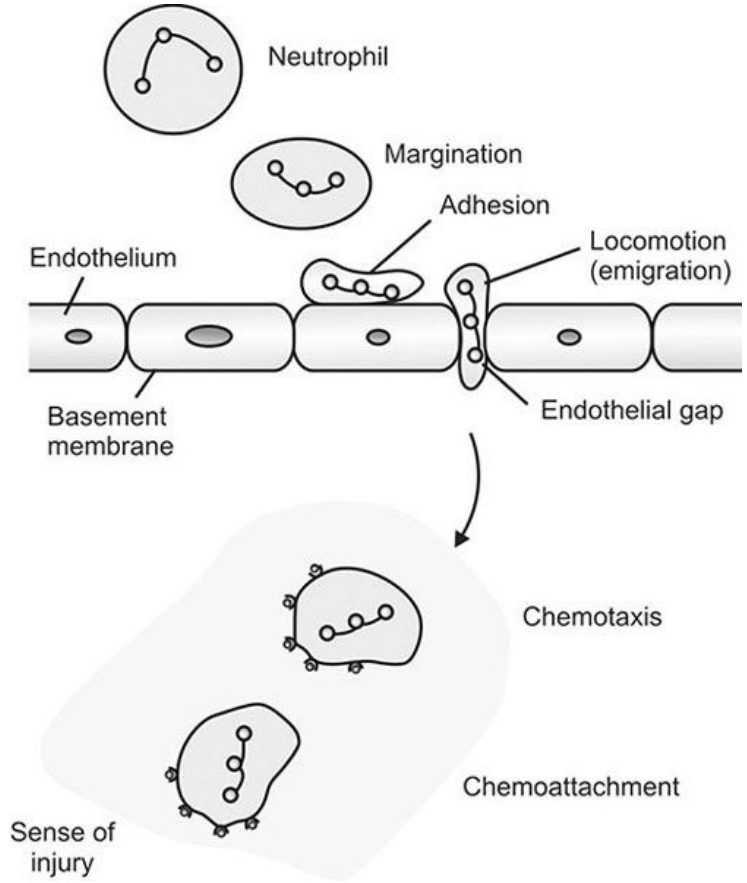




Inflammation

The cells of the immune system are widely distributed throughout the body. But if an infection occurs it is necessary to concentrate them and their products to the site of infection. This process is called inflammation.

- Changes in blood flow,
- An increase in permeability of blood vessels,
- The migration of fluid, proteins, and white blood cells (leukocytes) from the circulation to the site of tissue damage.



What if inflammation keeps going?

Inflammation

Acute

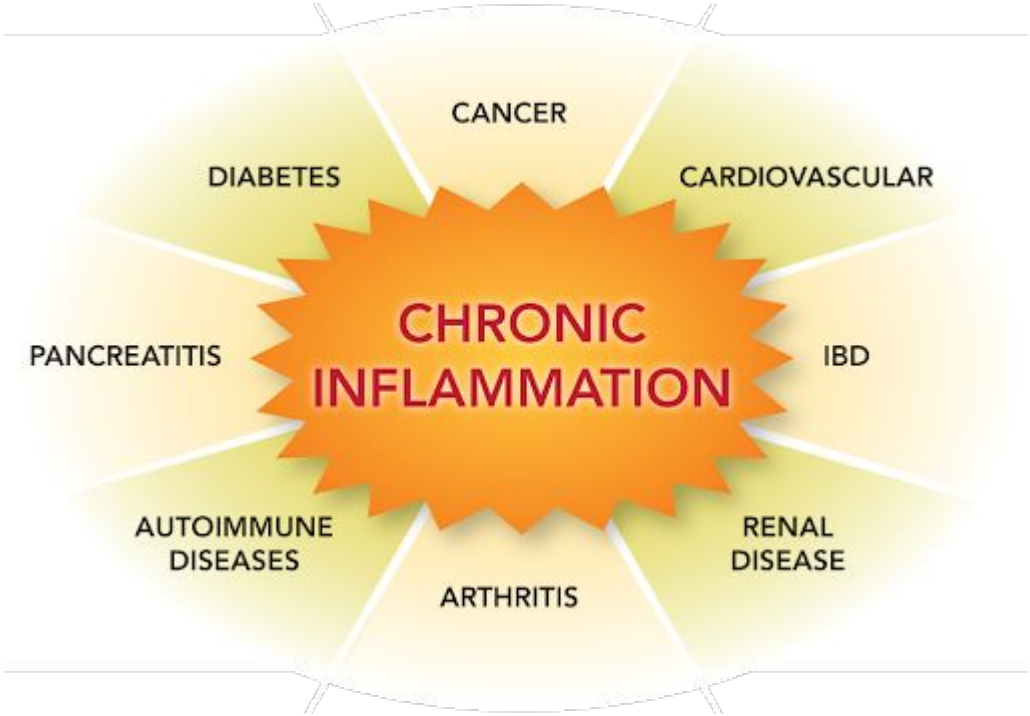
Redness
Heat
Swelling
Obvious & immediate reactions

Resolution

Chronic

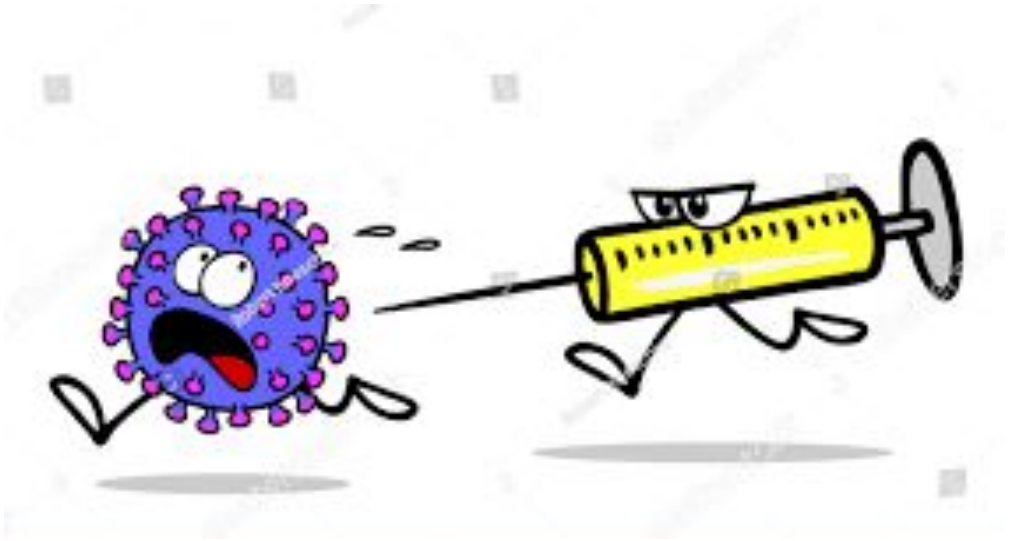
Sympoms not always obvious
Persistent pain (not "sharp", rather are dull)
Fatigue
Headaches
Gut distrubances
Brain Fog

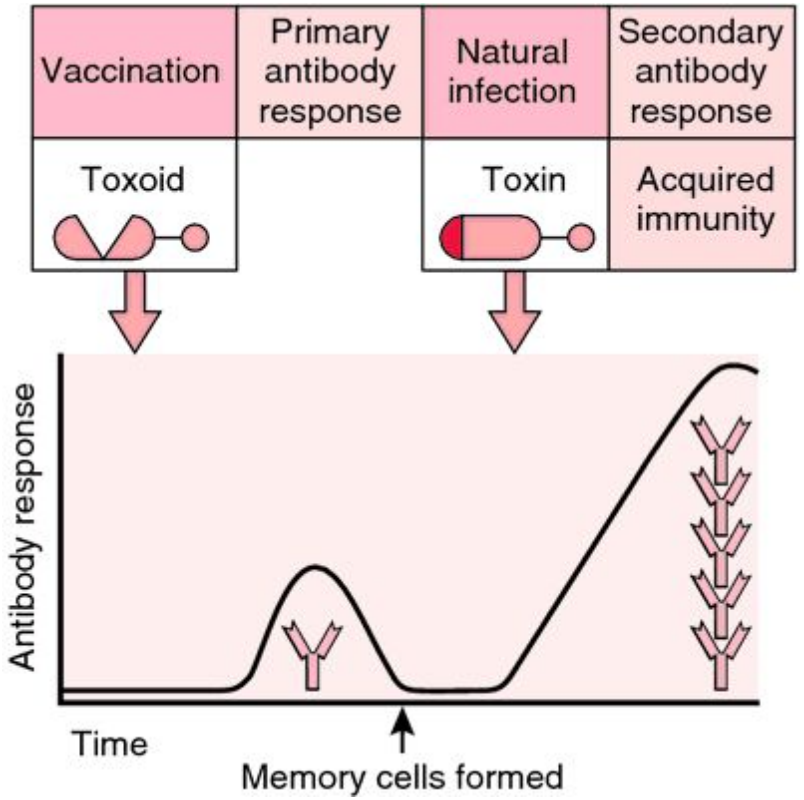
If not managed:
Chronic disease development
Autoimmune disease



Vaccination

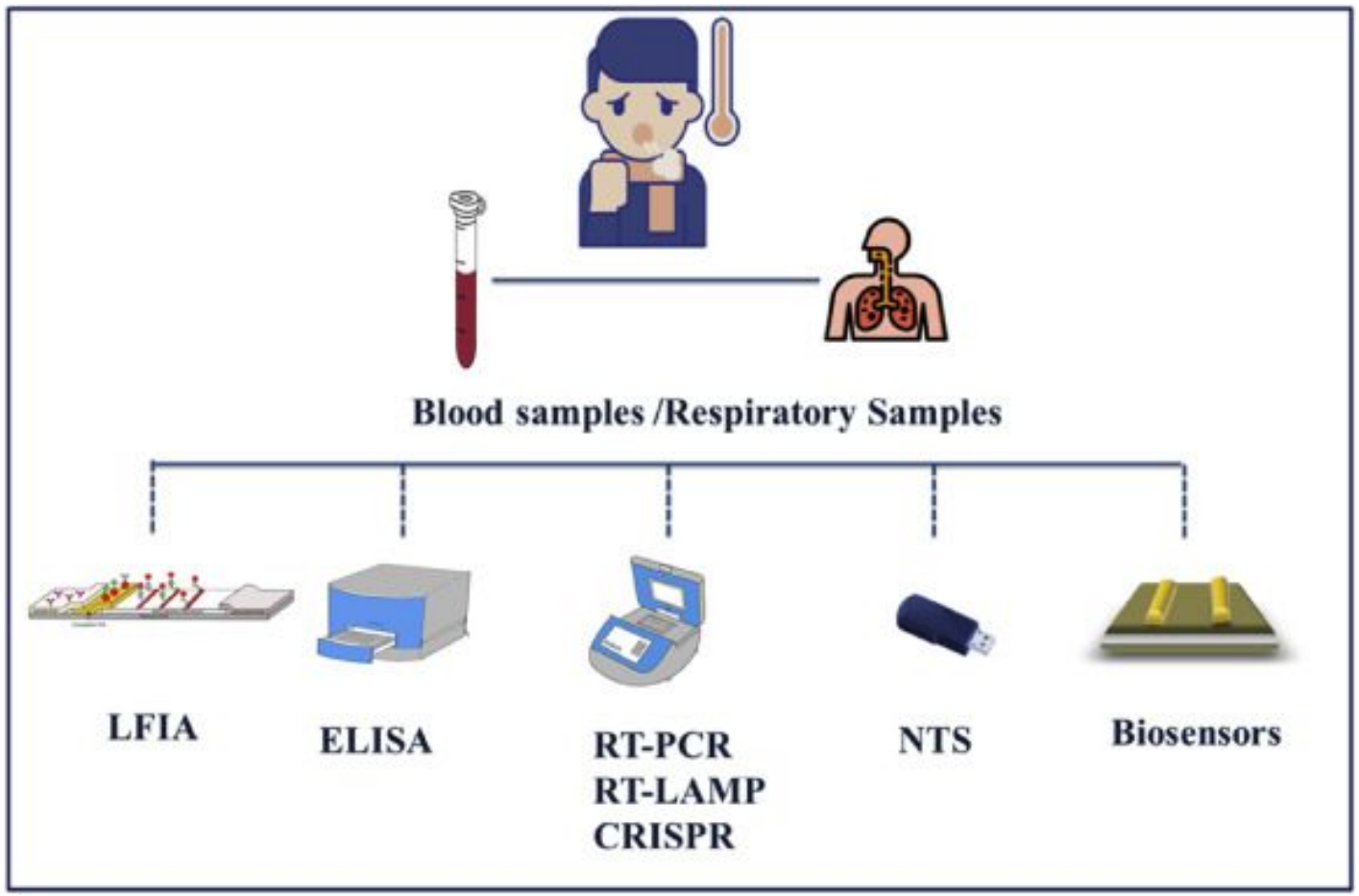
Two key elements: Specificity and memory.





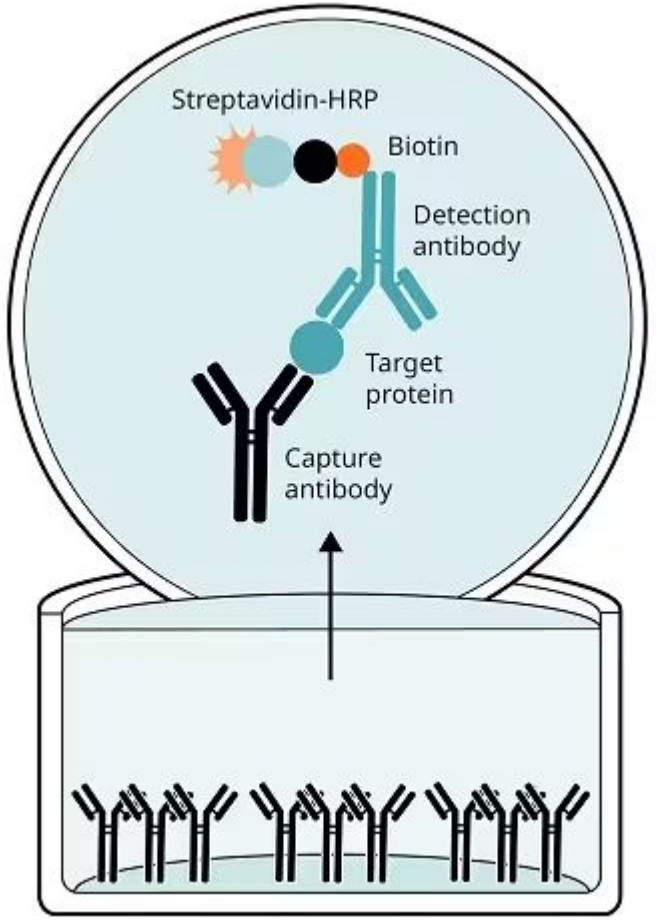
Immunization with tetanus toxoid. Chemical modification of tetanus toxin produces a toxoid which has lost toxicity but retains it’s epitopes.

Diagnosis


Blood samples /Respiratory Samples
LFIA
ELISA
RT-PCR
RT-LAMP
CRISPR
NTS
Biosensors

ELISA

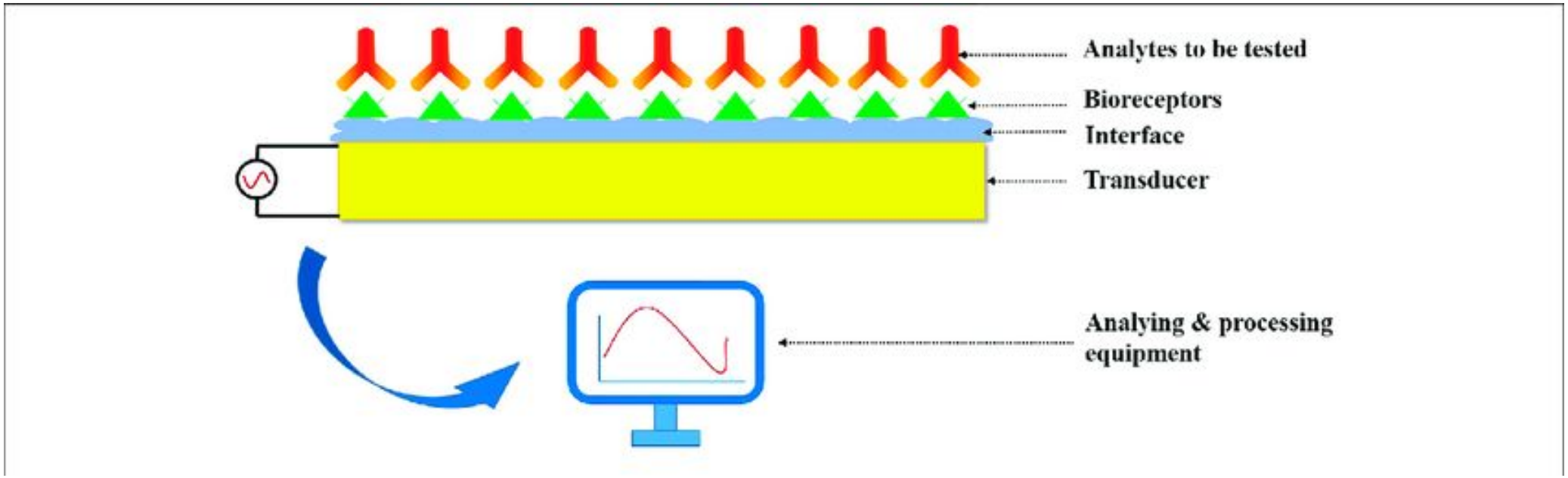
- ELISA (which stands for enzyme-linked immunosorbent assay) is a technique to detect the presence of antigens in biological samples. An ELISA, like other types of immunoassays, relies on antibodies to detect a target antigen using highly specific antibody-antigen interactions.
- Disease detected by ELISA
  - HIV
  - Lyme disease
  - COVID-19
  - Pernicious anemia
  - Rocky Mountain spotted fever
  - Squamous cell carcinoma
  - Syphilis



The basic setup of an ELISA assay. A capture antibody on a multi-well plate will immobilize the antigen of interest. This antigen will be recognized and bound by a detection antibody conjugated to biotin and streptavidin-HRP.

Another advanced technology: Biosensor

A biosensor is a device that converts biological phenomena into a recordable signal.



Example of biosensors

Pregnancy test

Detects the hCG protein in urine.

Glucose monitoring device (for diabetes patients)

Monitors the glucose level in the blood.