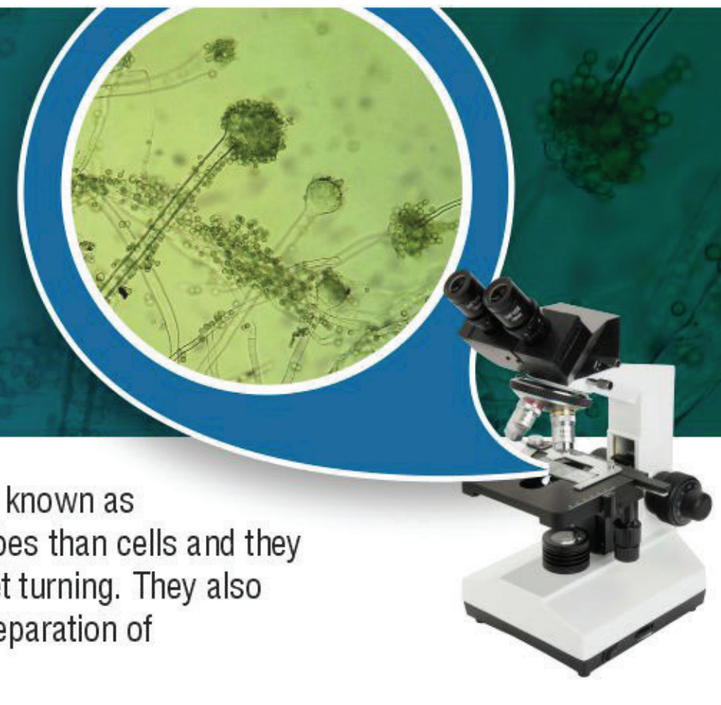
COVID-19 Science Outreach

MICROBES



About 2/3rd organisms on Earth are so small, that they can only be seen using a microscope. These organisms are known as 'microorganisms' or 'microbes' whose millions of species inhabit the Earth. A human body consists of more microbes than cells and they form the 'human microbiome'. The microbes are like tiny chemical processors that keep the life cycles of the planet turning. They also play key roles in nutrient cycling, biodegradation, climate change, food spoilage, cause and control of diseases, preparation of medicines, making of biofuels and in food industries.

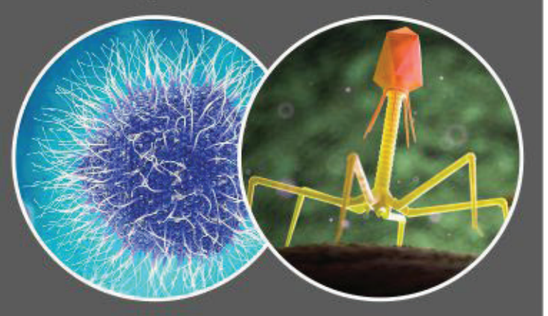
Bacteria

All around us

Bacteria, single-celled prokaryotes, were the first organisms to appear on Earth. They are considered as invisible backbone of all life systems. They can be found in soil, water, hot springs, ice & glaciers, radioactive waste, deep in the Earth's crust, plants, animals and humans - from high up in the stratosphere to deep down in oceans. Average size (diameter) of most bacteria is between 0.2 to 2.0 µm & they can be easily viewed with compound microscope.

Virus

Harmful, but also useful



Everyday, we breathe in thousands of viruses. These viruses are useful and harmless while only a few make us sick. They help the immune system to identify pathogens. They are the smallest of all the microbes. Most viruses vary in diameter from 20 to 400 nm. They can be viewed with a electron microscope. Viruses exist both as living and non-living. They can replicate only upon finding a host cell.

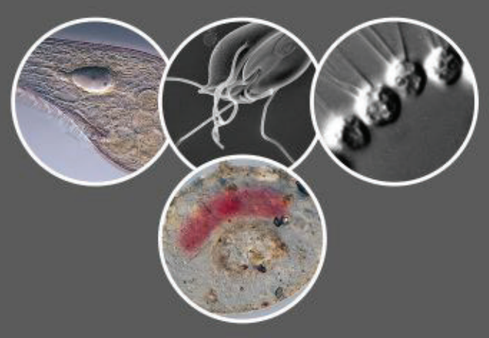
Fungi

Not just mushrooms

Fungi can be single-celled or have a complex cellular organization e.g. mushrooms. They are eukaryotes and mainly live in soil or on plant material. Fungal cell consists of membrane-bound nucleus with genetic material, cytoplasmic organelles and lack chloroplast. Many fungi have bright colours due to presence of red, green or black coloured pigments. Diameter of most fungi ranges from 2 to 10 µm. They can be observed under a compound microscope.

Protozoa

Universal microbes



Protozoa are single-celled eukaryotes and exist as free-living organisms or as parasites e.g. *Plasmodium falciparum*. They live in moist habitats like fresh water, marine environment and soil. Their size ranges from 10 to 100 µm in diameter e.g. Amoeba which can change its shape & Paramoecium with its fixed shape and complex structure. They can be viewed under compound & simple microscope.

Algae

Photosynthetic microbes

In humid climatic conditions, green velvety layer is seen on walls and rocks which is called as algae. These eukaryotes can exist as single cells or in clusters. Algae are mostly found in fresh and sea water, soil, leaves, bark or land animals. Algal cells contain chloroplast & are found in different colours like green, brown, red or yellow. Algal cells range from 0.5 µm in diameter to 60 m in length they can be viewed under compound microscope.

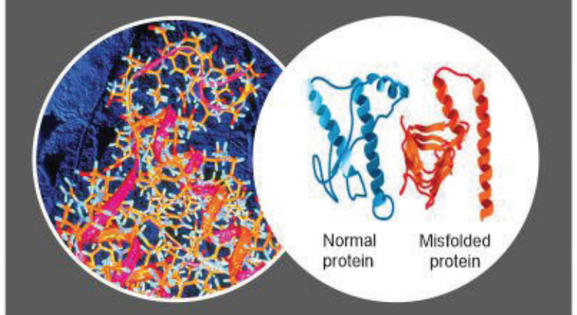
Archaea

Life in extremes

Archaea are single-celled, slow growing prokaryotes and similar to bacteria. They can be seen as filaments or in clusters with spherical, rod, spiral, lobed or irregular shapes. They are known for living in extreme environments like super-hot and freezing climates; acidic, alkaline, salty conditions; deep in oceans & places with high gamma or UV radiation. They are usually less than 1 µm long and can be viewed with electron microscope.

Prions

Abnormal Proteins



Prions are not cells but misfolded proteins which can replicate on their own. They cause many neuro-degenerative diseases like Mad Cow disease in livestock and CJD in humans. These proteins do not multiply in the host organism that they infect. Instead, they affect the brain structure by making the normal protein folding into abnormal prion form. They can be viewed under electron microscope.

Spread of microbes

Disease-causing microbes are called pathogens.

Droplet contact
Coughing or sneezing on another person.

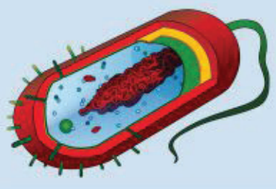
Direct physical contact
Touching an infected person.

Touching contaminated soil or water.

Airborne transmission
Through microbes present in air.

Fecal oral transmission
Intake of contaminated food or water.

Contamination
By unclean intravenous syringe, organ transplant or blood transfusion.



Prokaryotic organisms lack a cell nucleus or any membrane-bound organelles.

Eukaryotic organisms have a membrane-bound nucleus that holds genetic material, as well as membrane-bound organelles.

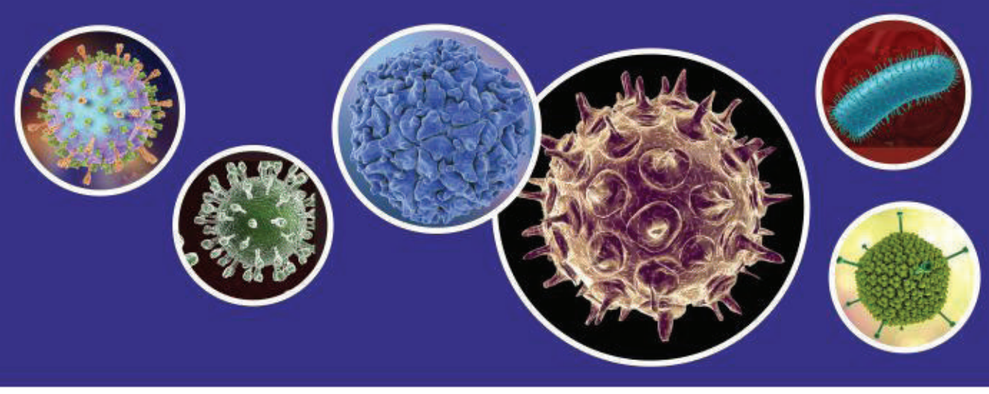
References: www.science.org.au, www.microbiologysociety.org, www.sciencedirect.com, www.britannica.com, www.science.howstuffworks.com, www.news-medical.net, www.microscopemaster.com

Catalysed and supported by
Department of Science & Technology
Government of India
रविप्रौसंप NCSTC

Developed by
VIKRAM A SARABHAI
COMMUNITY SCIENCE CENTRE

COVID-19 Science Outreach

VIRUS



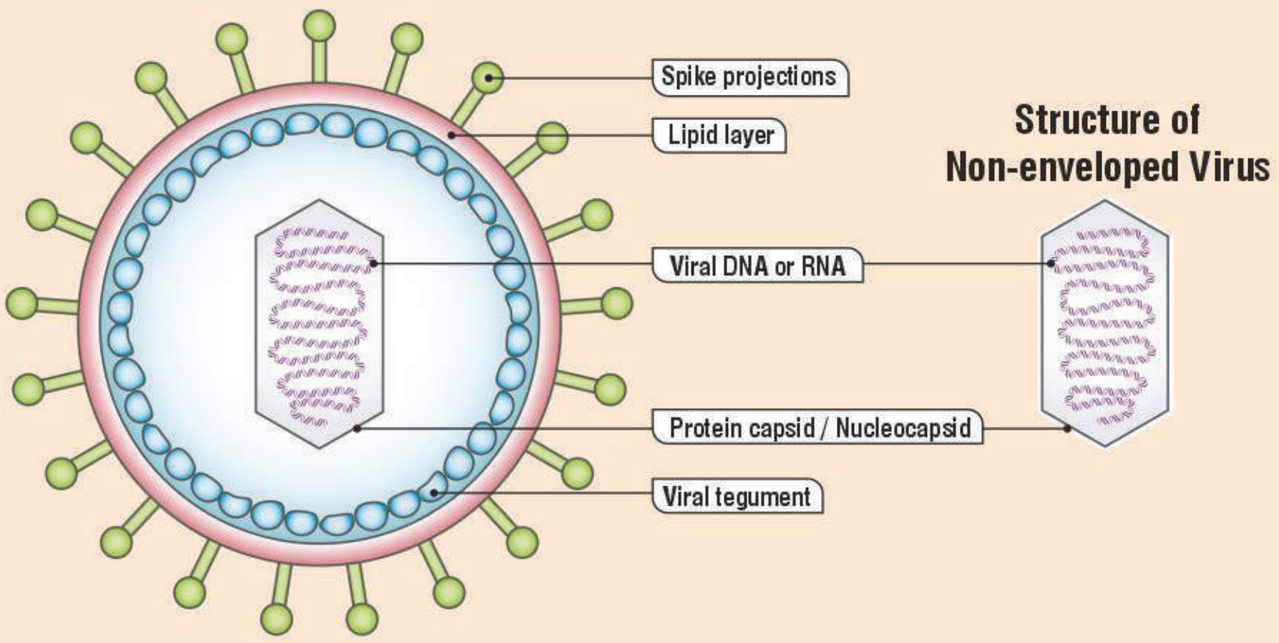
Virus contains nucleic acid, either DNA or RNA (but not both), and a protein coat. Virus, in this form is non-infective and known as a 'virus particle'. When a virus is in its infective form, it is known as a 'virion'.

Virus can be considered neither as living nor nonliving. It cannot replicate on its own but can replicate if it finds suitable living organism.

The capacity of any microorganism (bacteria, fungi or virus) to cause damage in a host is referred as 'pathogenicity'. The degree of damage caused by the microorganism is known as 'virulence'.

Viruses mostly have rods or filament shape. Some viruses are as long as 1 µm in diameter. Viruses exist only to make more viruses.

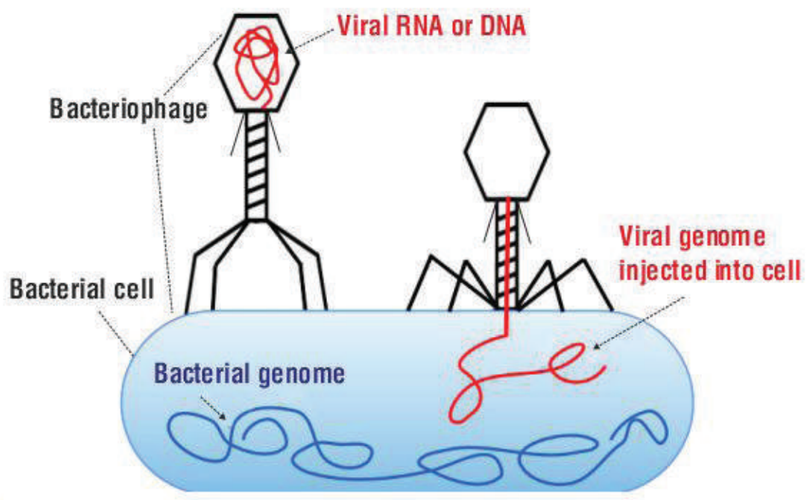
Structure of Enveloped Eirus



Structure of Non-enveloped Virus

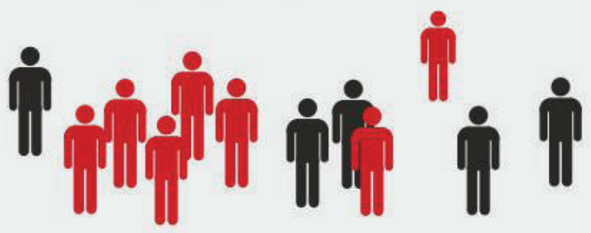
Phagocytosis is a process by which phagocytes e.g. amoeba or WBCs, ingest or engulf other cells or particles. Phagocyte name comes from the Greek word 'phagein' means 'to eat' and 'cyte' means cell.

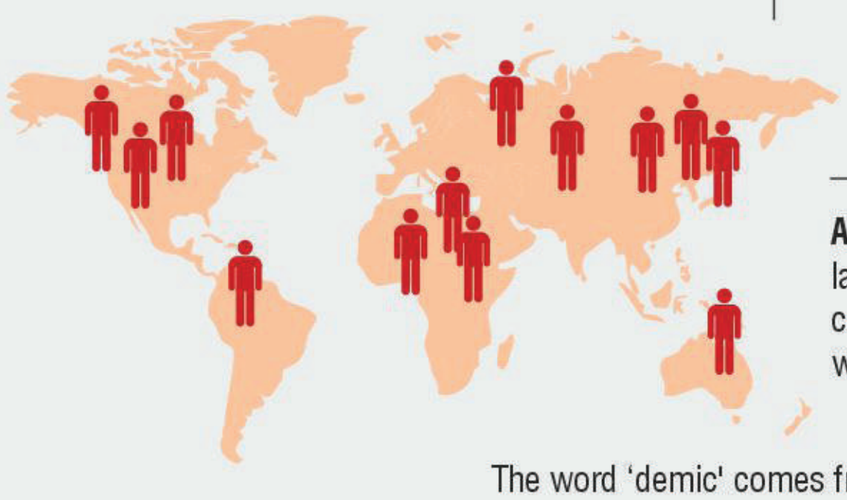
The classification of virus is based on the organism it infects. If a virus infects a bacterium, it is called as 'Bacteriophage' or 'phage'. Bacteriophage actually means 'Bacteria eater'. Depending upon the host cell, there is 'plant virus', 'animal virus' and 'human virus'.



An outbreak is a sudden increase in number of cases of a disease. e.g. Nipah virus, Chikungunya.

An epidemic is a disease that is 'affecting many persons at the same time, and spreading from person to person in a locality where the disease is not permanently prevalent'. It occurs at the level of a region or community. e.g. Plague, Smallpox.

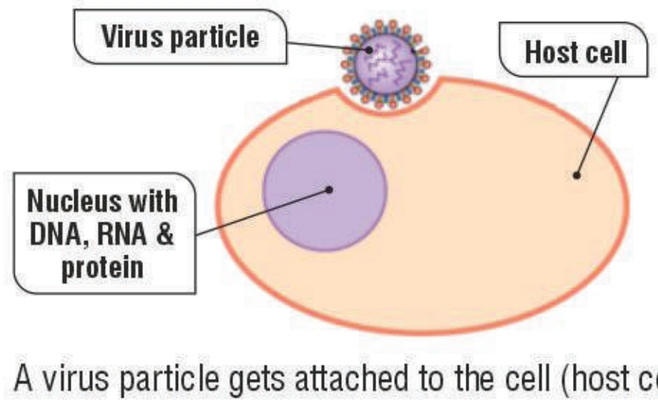




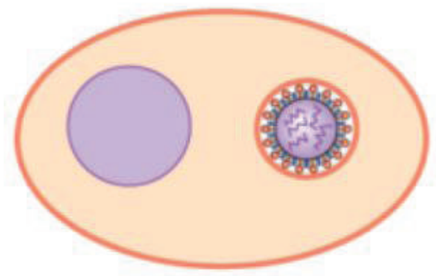
A pandemic is an epidemic that has spread over a large area, that is, it is 'prevalent throughout an entire country, continent, or the whole world'. It is a world widespread of a new disease. e.g. H1N1, COVID-19

The word 'demic' comes from Greek word 'demos' meaning 'people of district'.

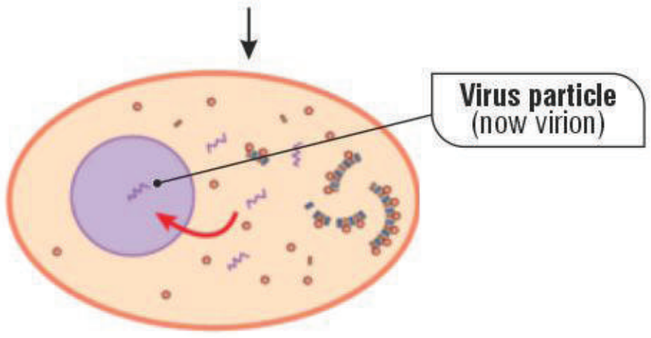
Stages of virus infecting a cell (Lytic cycle)



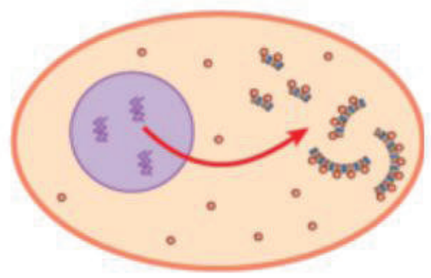
A virus particle gets attached to the cell (host cell).



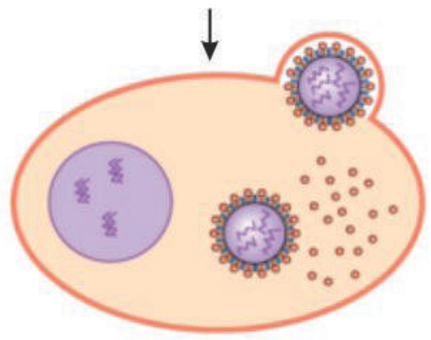
The virus particle enters into the host cell by breaking the cell's outer membrane.



Virion releases DNA or RNA to use enzymes & genetic material of host cell for its replication.

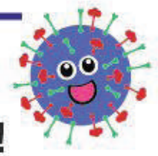


New virus particles are formed.



The new particles break free from host cell. In this process, either the host cell gets killed or continuously makes new virus particles.

Did you know?



Certain viruses are beneficial to us!

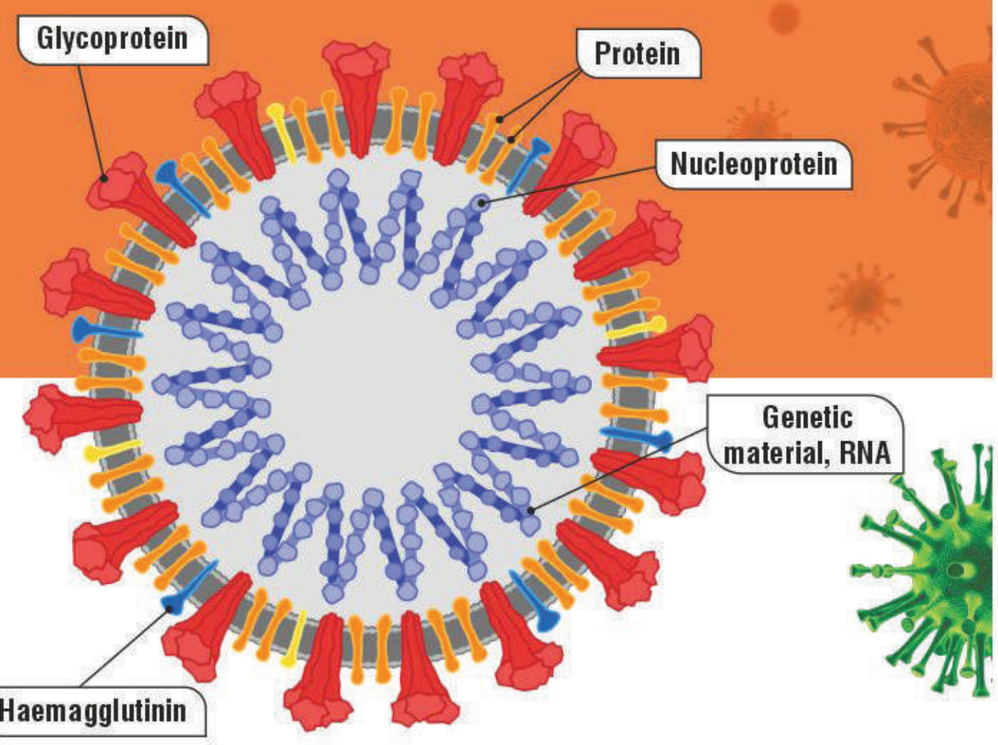
Viral infections at a young age helps immune system to develop properly and provide protection against future infections. e.g. presence of harmless virus in saliva eliminates harmful bacteria, if any.

References: www.courses.lumenlearning.com, www.micro.magnet.fsu.edu, www.science.howstuffworks.com, www.nature.com, www.whatisbiotechnology.org, www.the-scientist.com, www.edition.cnn.com, www.history.com, www.britannica.com

Catalysed and supported by
Department of Science & Technology
Government of India
राविप्रौसंप NCSTC
Developed by
VIKRAM A SARABHAI COMMUNITY SCIENCE CENTRE

COVID-19 Science Outreach

COVID-19



Coronaviruses (family *Coronaviridae*) are a group of RNA viruses that cause diseases in mammals and birds. COVID-19 is a new infectious disease (**CO** stands for **Co**rona, **VI** for **Vi**rus, and **D** for **D**isease and **19** for the year 20**19**). COVID-19 disease was called as novel (meaning 'new') coronavirus as these type of coronaviruses have not been seen in humans before.

According to WHO, the official names of disease and virus are both different. The disease is called **Coronavirus Disease (COVID-19)** while virus is called **Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)**. Coronavirus structure has lipid outer membrane layer with club-shaped glycoprotein spikes. The envelope gives the virus a crown-like or coronal appearance; hence the name.

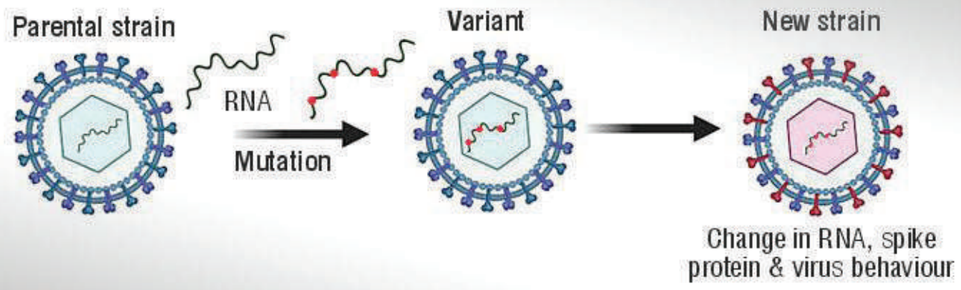
Transmission

Respiratory infections can be transmitted through droplets of different sizes. When the droplet particles are bigger than 5-10 µm in diameter they are referred to as respiratory droplets. When then are smaller than 5 µm in diameter, they are referred to as droplet nuclei. According to current evidence, COVID-19 virus is primarily transmitted between people through respiratory droplets and contact routes.

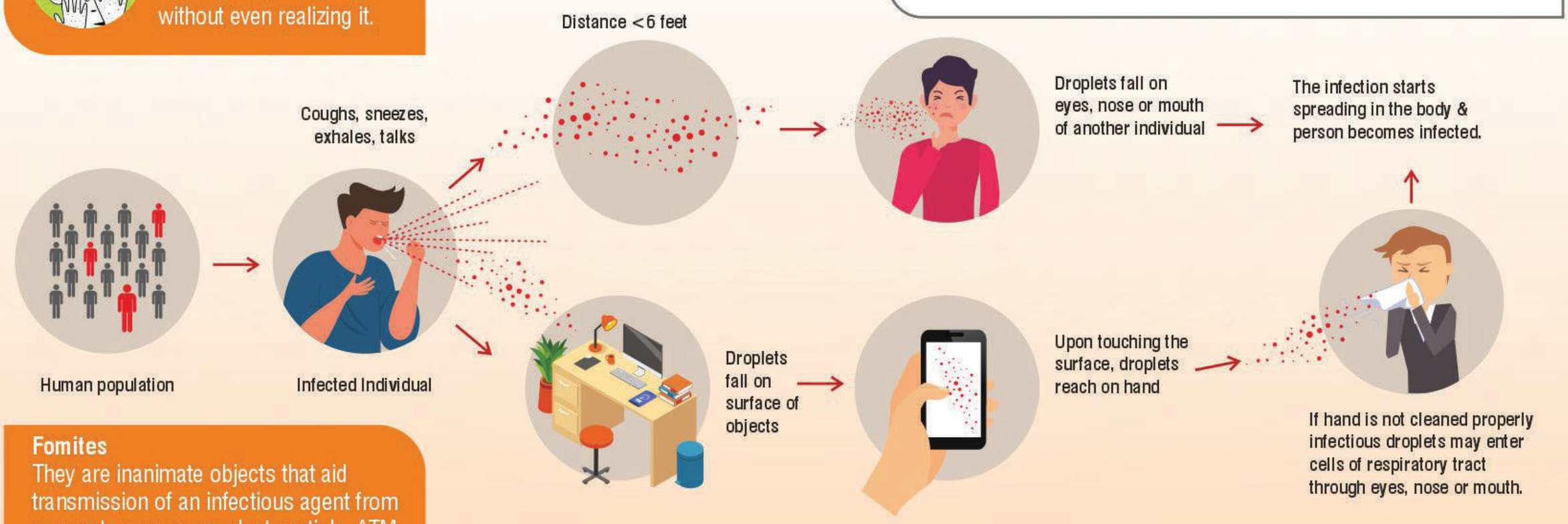
In a study, it was found that people touch their face 23 times in an hour without even realizing it.

Mutations *Like spelling error in a word*

Mutations are essential to evolution & occur due to various environmental factors. Every organism to survive in the fittest form undergoes mutation. If the mutation has a positive effect on an organism then it is called as adaptation.



Every cell consists either DNA or RNA or both. Mutations are permanent alterations (change) to any gene sequence.



Fomites
They are inanimate objects that aid transmission of an infectious agent from person to person e.g. dust particle, ATM machine, mobile phone etc.

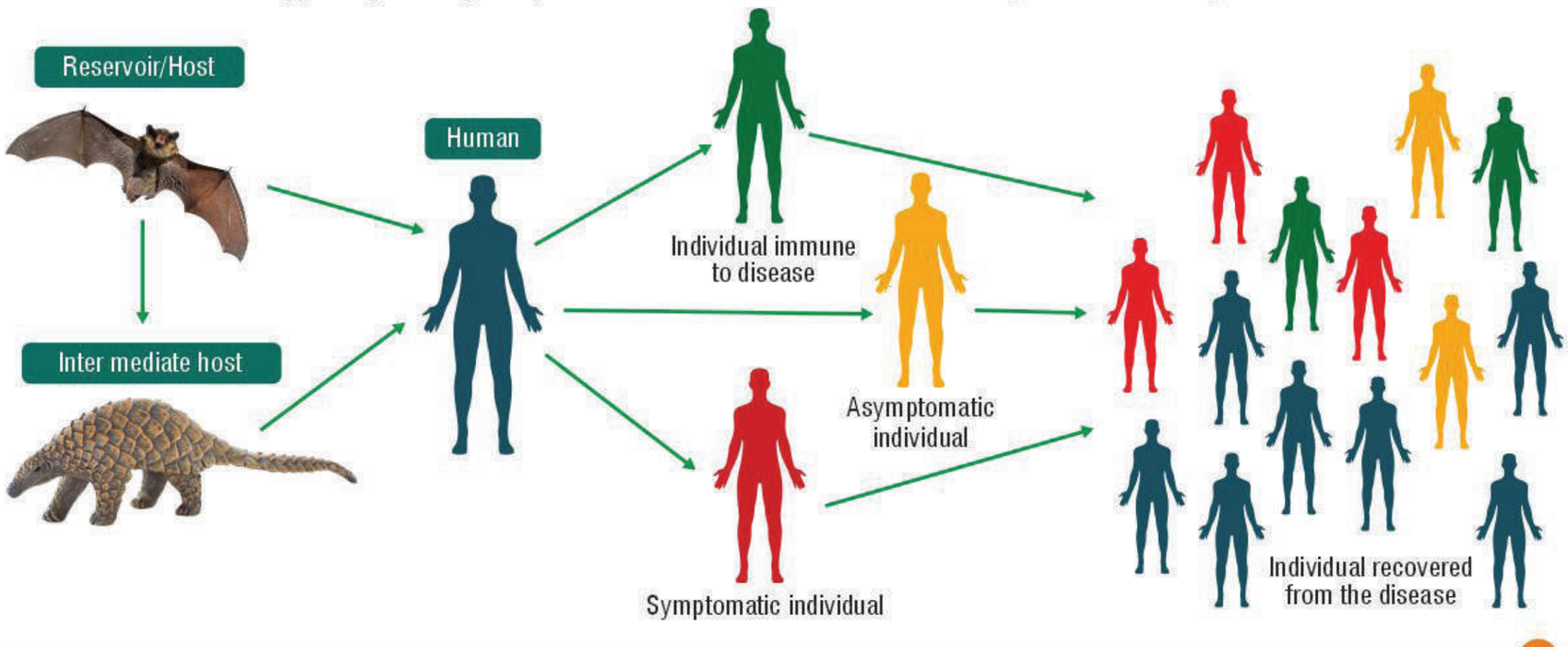
Depending upon the type of surface, temperature or humidity in environment; coronavirus may persist on surfaces for a few hours to several days.

Spread of an infectious disease

The spread of a disease depends upon its transmission among individuals. Transmission occurs through two major ways:

Symptomatic transmission refers to transmission of a disease from individuals who experience signs & symptoms.

Asymptomatic transmission refers to transmission of a disease from individuals who do not show any signs & symptoms. These individuals are called as 'carriers' or 'silent spreaders', as they unknowingly play a major role in spreading the disease.



References: www.who.int, www.ncbi.nlm.nih.gov, www.cdc.gov, www.sciencedirect.com, www.britannica.com, www.medlineplus.gov, www.livescience.com, www.nature.com

Catalysed and supported by
Department of Science & Technology
Government of India
रविप्रौसंप NCSTC
Developed by
VIKRAM A SARABHAI COMMUNITY SCIENCE CENTRE

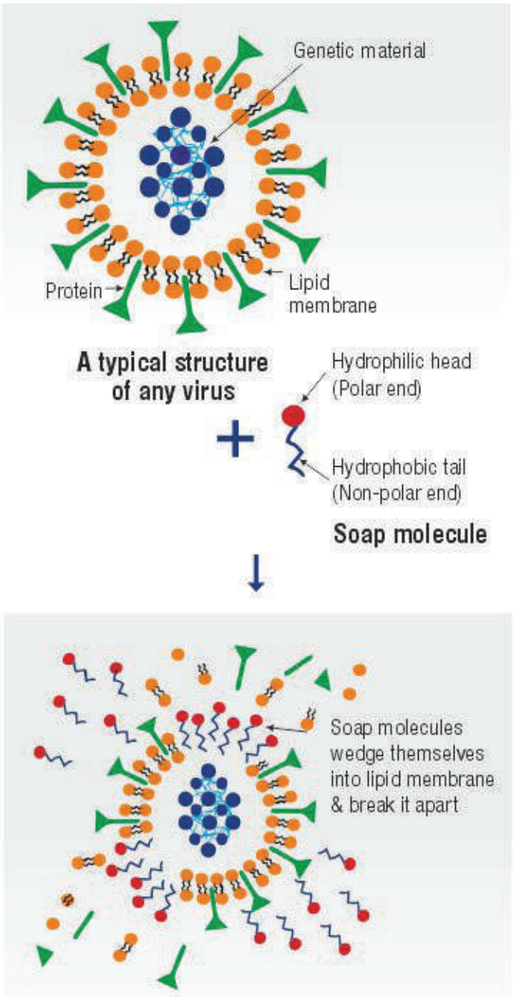
COVID-19 Science Outreach

PREVENTIVE MEASURES

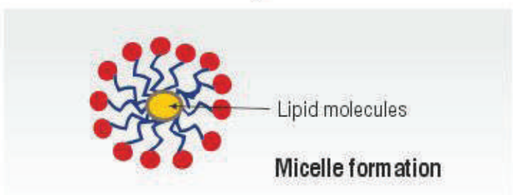
Microbes are present on all surfaces of the hand, specially under the nails. Many diseases, infections and conditions are spread by not washing hands properly.

Soap

Washing hands thoroughly with soap & water for 60 seconds removes microorganisms, dirt & grease. This includes washing the back of hands, in between fingers and under the nails.



The outer membrane of virus (or any microorganism) breaks due polar and non-polar ends of soap molecule.



Proteins and other molecules required for causing infection are lost.

Bleach

Bleach oxidizes & destroys virus proteins and genetic material. It works effectively when used with minimum of 0.1% sodium hypochlorite (NaClO) concentration is used and left on surface for 10 minutes.

Caution: Mixing bleach with disinfectants can generate toxic chlorine gas.

Sanitizers

Alcohol-based hand sanitizers contain 60-95% ethyl alcohol, isopropyl alcohol or n-propanol or a combination of them. Mostly all gel-based hand sanitizers contain chlorhexidine or benzalkonium chloride with glycerol and hydrogen peroxide.

How do hand sanitizers protect against infections?

Washing hands with alcohol-based sanitizer for more than 30 seconds kills most microorganisms by denaturing proteins and dissolving lipid membranes (except for virus which lacks envelope). Gel-based sanitizers lack this effectiveness. Alcohol-based sanitizers should be used by children under adult supervision only.

Sanitizers are not effective in presence of dirt, grease or harmful chemicals like pesticides & heavy metals on the hands.

Hydrogen Peroxide

Hydrogen peroxide with minimum 0.5% concentration of peroxide, oxidizes & destroys virus proteins and genetic material. It has been proven effective when left on a surface for 10 minutes.

Personal Protective Equipment (PPE)

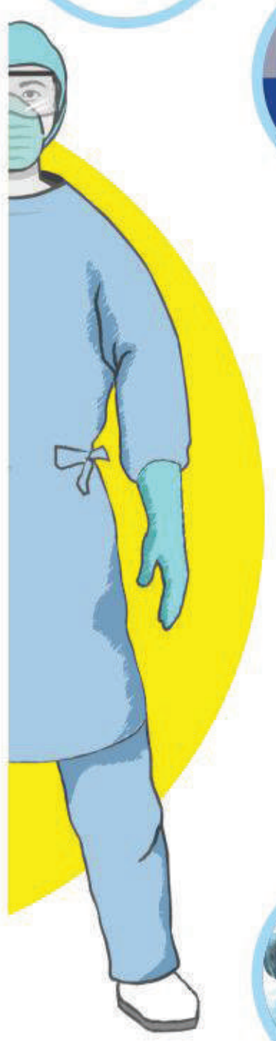
PPE is specialized clothing worn as a control measure for infection prevention.

Head cover

Protect the hair and scalp from airborne contaminates.

Face shield and goggles

Protect mucous membranes of eyes, nose and mouth from infection.



Masks

Protect the crucial airway passage. It is advisable to not reuse single-use masks & follow standard protocols of wearing & removing the mask.

Gloves

Nitrile (synthetic) or latex (natural rubber) gloves helps to stay safe from surface contamination. Comparatively, nitrile gloves are less allergic and more resistant against chemicals.

Coverall/gown

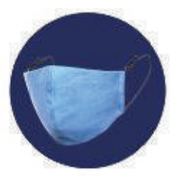
A fluid- and air-resistant woven plastic fibre provides 360° protection to the whole body from infection.

Shoe covers

They are made up of impermeable fabric to facilitate protection and decontamination.

Triple layer medical mask/surgical mask
A fluid-resistant disposable mask prevents wearer from spreading the infection while coughing / sneezing / talking.

N-95 Respirator
More efficient than surgical mask, has high filtration efficiency & can screen out 95% of small airborne particles (min. size of 0.3μ).



Non-medical cloth mask (3 layered or more)
It is advisable to use tightly woven material like 100% cotton for better efficiency.

Why wearing valve mask is not advisable?
Valve mask filters air only during inhalation while during exhalation the valve opens out and allows unfiltered air to come out. So, chances of an asymptomatic carrier or person with coronavirus infecting others become very high.

HAZMAT suit

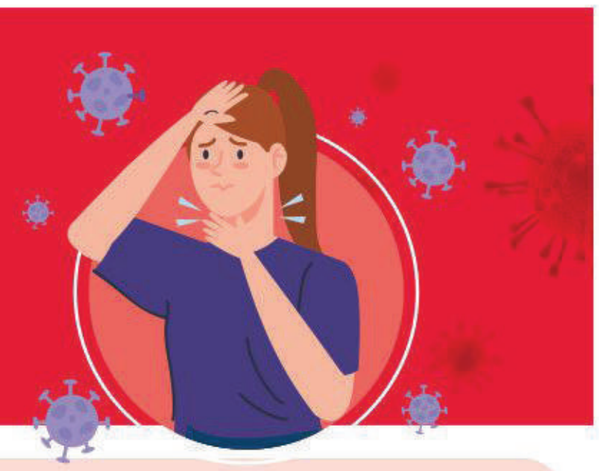
A HAZMAT suit is short for HAZardous MATerial suit, designed to protect against harmful biological, chemical agents. This whole-body suit is a form of PPE. They are classified into 4 levels - A, B, C & D; with A giving highest level of protection.

References: www.who.int, www.ncbi.nlm.nih.gov, www.dailymail.co.uk, www.cdc.gov, www.cidrup.umn.edu, www.science.org.au, www.microbiologysociety.org, www.sciencedirect.com, www.britannica.com

Catalysed and supported by
Department of Science & Technology
Government of India
राविप्रीसंप NCSTC

Developed by
VIKRAM A SARABHAI COMMUNITY SCIENCE CENTRE

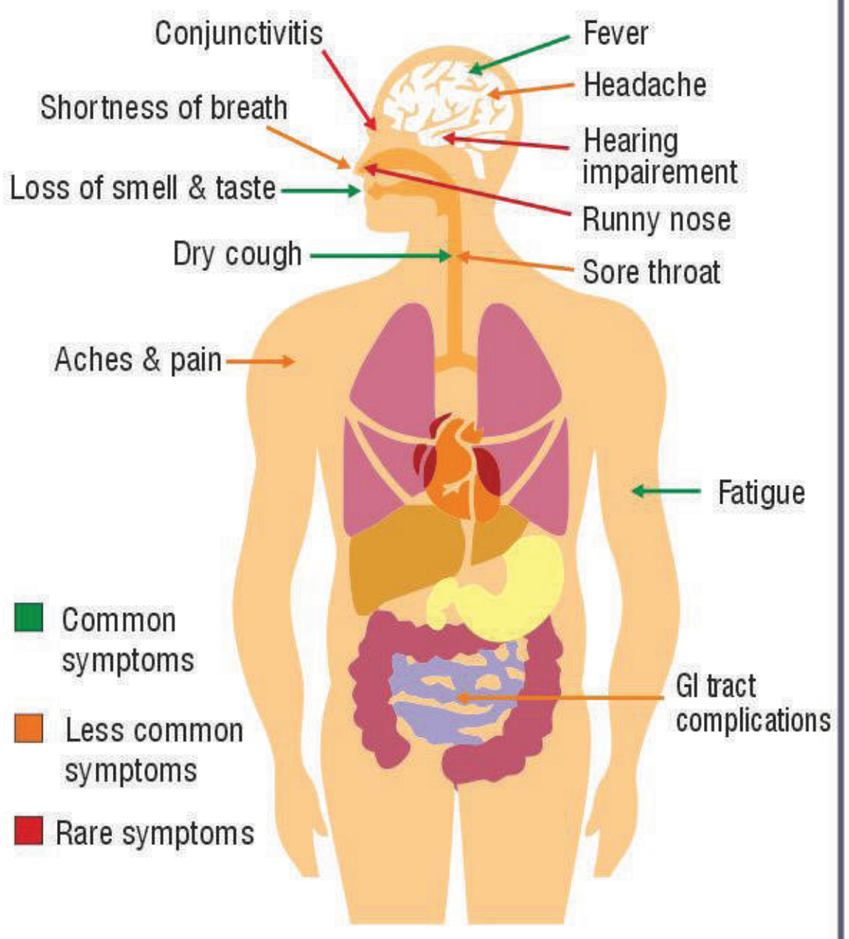
SYMPTOMS & EARLY DETECTION



The onset of coronavirus is sudden. For symptomatic and asymptomatic individuals, incubation period ranges between 1-14 days and may even go up to 24 days. Mild cases take about 2 weeks to recover but for severe cases, it may take up to 6 weeks. Since this virus is mutating, continuous research is going on to study the changes in transmissibility, virulence and symptoms.

Mucormycosis, a rare fungal infection is sometimes observed in patients with low immunity & co-morbid conditions. This infection starts in nasal area, throat, then spreads into the entire body.

Common Symptoms of SARS-CoV-2



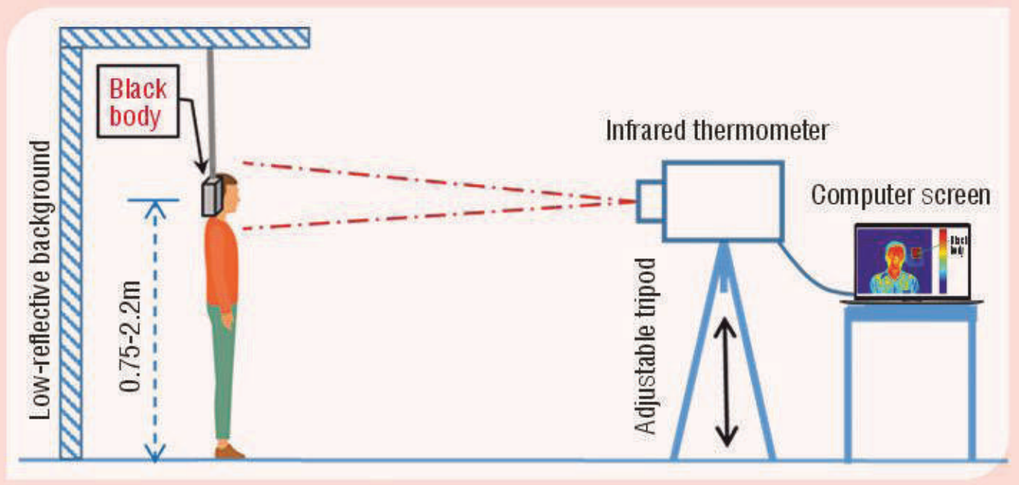
Symptoms vary from person to person in occurrence and severity

Detection

The most common symptom of any type of infection is fever. It is caused as pyrogens (fever inducing agents) are released in the body. These pyrogens trigger the hypothalamus (thermostat of our body) which increases the body temperature. Fever can be detected by thermal imaging systems or non-contact infrared thermometer (NCIT).

Thermal Imaging System

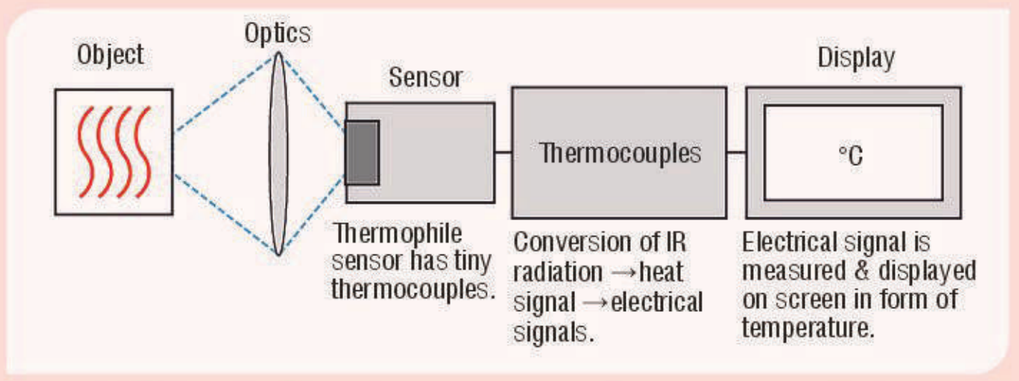
The system includes an infrared thermal camera and may have a temperature reference source. It measures the skin temperature of the person without being physically close.



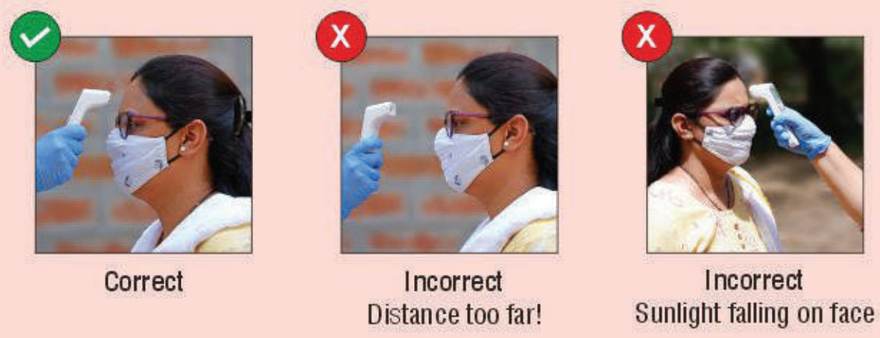
Black body is used for calibration of infrared sensor during evaluation.

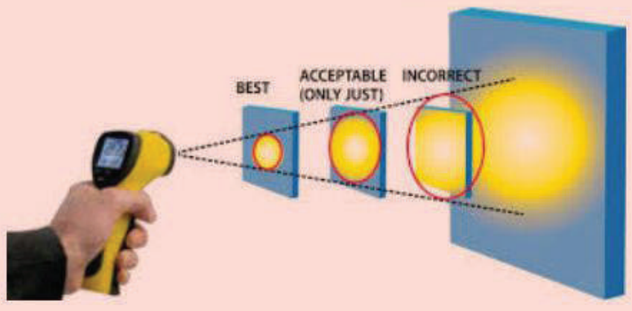
Non-Contact Infrared Thermometers (NCITs)

NCITs use reduces the risk of spreading disease. Normal temperature of human body is 98.6°F. Some studies have shown that normal body temperature can range from 97°F to 99°F. It measures mid to long wave infrared radiation and converts it into temperature.



It is advisable to hold the thermometer sensing area perpendicular to forehead & instruct the person to remain stationary during measurement.





98.6 °F
GREEN
<99.0 °F

101.0 °F
YELLOW
<102.0 °F

103.0 °F
RED
<104.0 °F

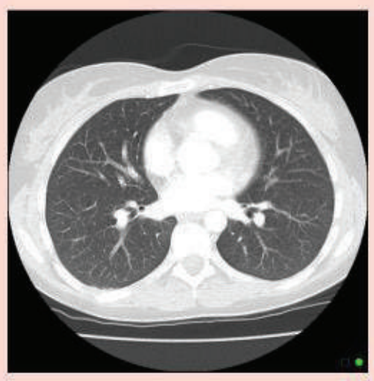
Thermal images do not show

- Structural problems in body
- Details about diagnostic diseases

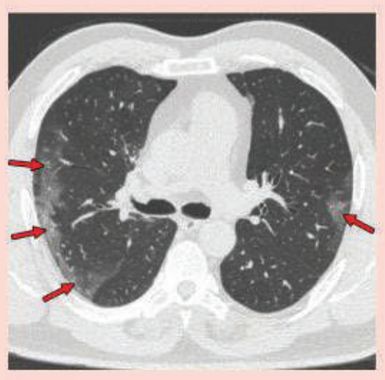
This method is non-invasive & radiation free.

HRCT

High Resolution Computed Tomography (HRCT) Scan is used for diagnosis and monitoring of diseases of the lung tissue and the airways. In scan of COVID-19 infected patients, Ground Glass Opacity (GGO) is seen during early phases of infection. It can be inferred from GGO pattern that there is blockage in air cavities.

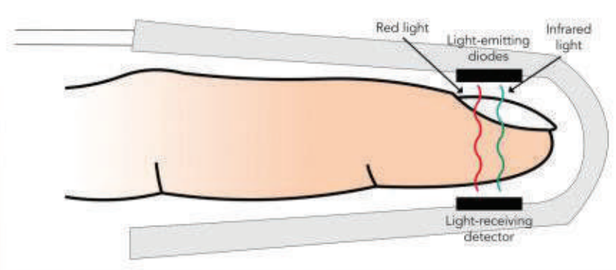


HRCT Scan of normal individual



HRCT Scan of SARS-CoV-2 infected individual with GGO

Oximeter



Oximeter works on the principle of Beer-Lambert's law

An oximeter uses small beams of infrared light to measure the oxygen saturation (SpO2) of the blood and the pulse rate (PR) when placed on a fingertip. SpO2 gives information about the amount of oxygen carried in the blood in percentage. Pulse rate is the number of heart beats per minute. In normal conditions, SpO2 levels are between 95% to 100%. Lower levels are seen in individuals living at higher altitudes or those having lung problem.

It advisable the consult the doctor immediately in case of any abnormal reading in oximeter.

References: www.who.int, www.cdc.gov, www.grainger.com, www.achieveintegrativehealth.com, www.howstuffworks.com, www.axis.com/files/articles/Ch5_thermalcameras.pdf, science.howstuffworks.com, www.nature.com

Catalysed and supported by
Department of Science & Technology
Government of India
रविप्रौसंप NCSTC
Developed by
VIKRAM A SARABHAI COMMUNITY SCIENCE CENTRE

COVID-19 Science Outreach

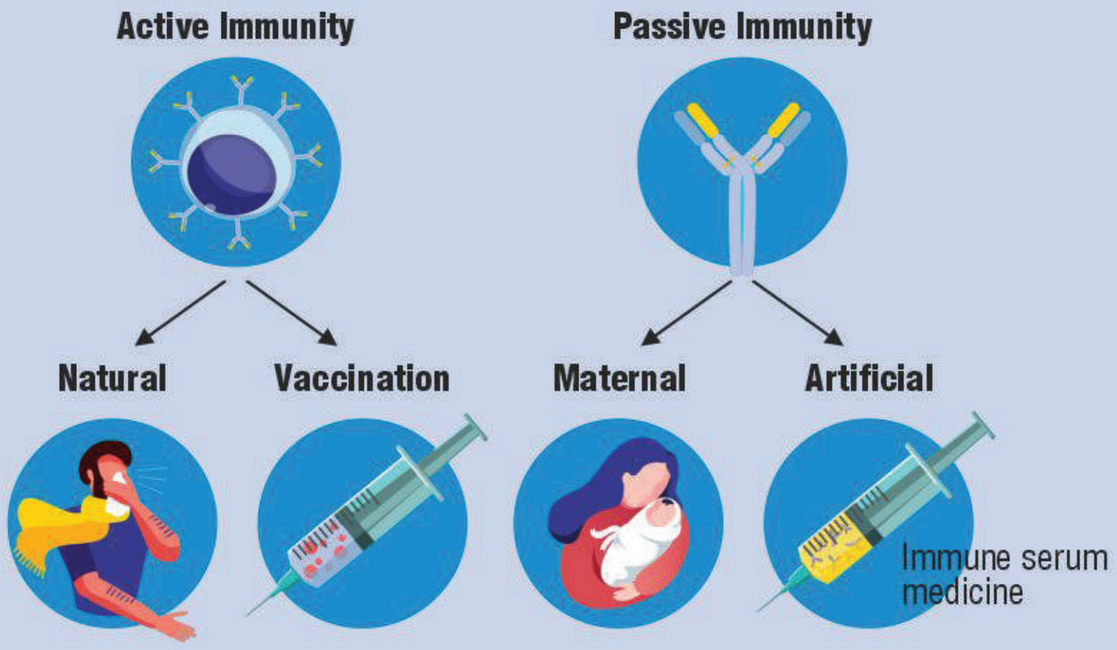
IMMUNITY

Immunity is defined as an organism's ability to protect itself from an unknown antigen. It is usually acquired naturally, but can also be induced by vaccination.

Innate Immunity

Innate immunity refers to non-specific defense mechanisms which becomes active immediately or within hours of an antigen's appearance in the body. This natural / genetic immune responce is due to neutrophils, macrophages, eosinophils, basophils, mast cells, and dendritic cells.

Adaptive Immunity



Adaptive immunity refers to antigen-specific immune response. This response is more complex than the innate response and it depends on:

- Administration and recognition of antigen
- Attack with an army of immune cells, released by immune system.
- An 'immunological memory' is created which helps immune system attack more rapidly, efficiently & effectively in case of second encounter with same type of antigen.

Adaptive Immune Response (Acquired immunity) include B cells (or B lymphocytes) and a variety of T cells (or T lymphocytes).

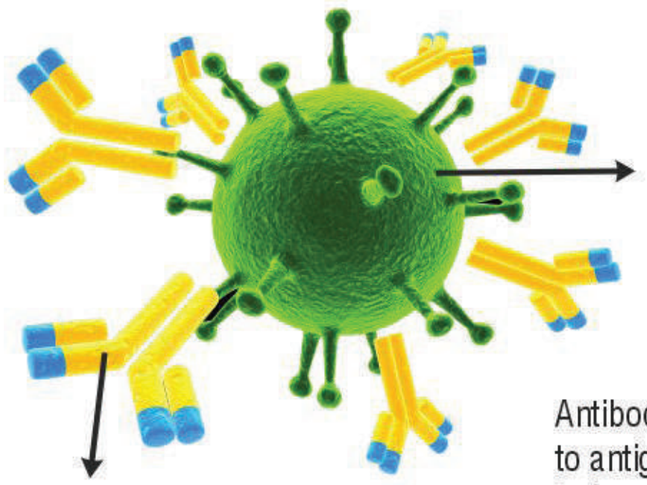
Edward Jenner performed the world's first vaccination in 1796. He observed that milkmaids did not catch smallpox. He assumed that as milkmaids had exposure to cowpox they became immune to smallpox. He took pus from a milkmaid with cowpox & inserted into a cut made in the arm of a local boy. Later, he exposed the boy to smallpox & found him immune. He called this new method 'vaccination' after the Latin word for cow (vacca).

Immunity Boosters *Some self-care measures during COVID-19 pandemic*

- Drink warm water throughout the day.
- Daily practice of Yogasana, Pranayama and meditation for at least 30 minutes as advised by Ministry of AYUSH
- Spices like Haldi (Turmeric), Jeera (Cumin), Dhaniya (Coriander) and Lahsun (Garlic) are recommended in cooking.

Visit : www.ayush.gov.in for more details.

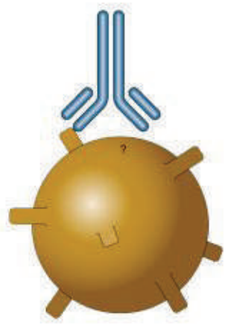
Antigen and Antibody



Antigen (Ag) - A particle, foreign to human body whose presence in the body triggers immune response, produced by antibodies.

Antibody (Ab) - Protective proteins produced naturally by the immune system in response to antigens.

Antibodies attach to antigen surface to form strongest binding Ag-Ab complex, resulting in inactivating or killing the antigen.

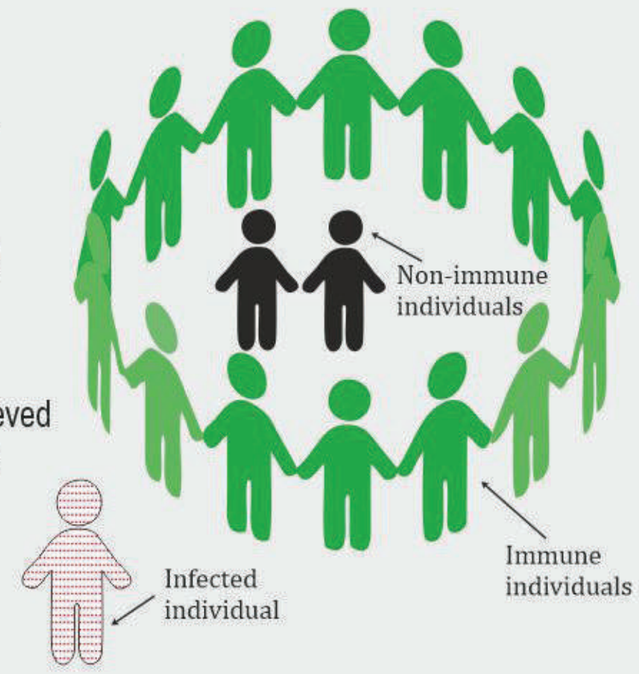


Ag-Ab Complex

Herd Immunity

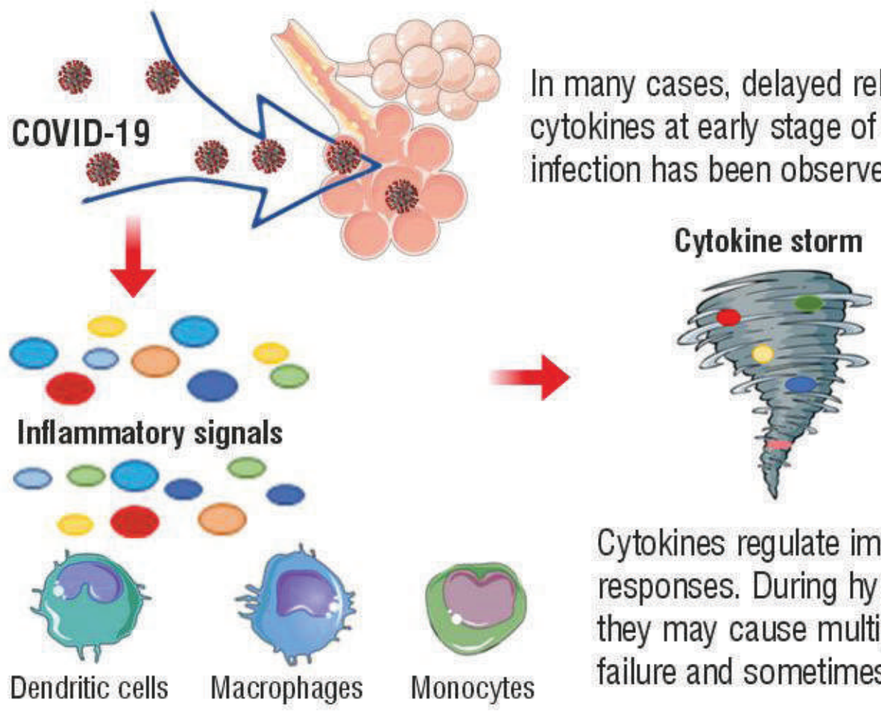
Also known as community immunity, this form immunity occurs when large portion of population becomes immune to an infectious disease. Herd immunity tends to limit the spread of disease.

This level of immunity is achieved when a population is immune either through vaccination or immunity developed through previous infection.



Have you heard of cytokine storm?

Cytokines are proteins which as part of the immune system, regulate the body's response to a disease and also act as messengers for immune system.



In many cases, delayed release of cytokines at early stage of SARS-CoV-2 infection has been observed.

Cytokines regulate immune responses. During hyper reaction they may cause multiple organ failure and sometimes even death.

Due to delay in release of cytokines, cells secrete high levels of cytokines which cannot identify the difference between normal and virus infected cells. This phenomenon of release in abnormally high quantity of cytokine proteins is considered as Cytokine storm.

References: www.vaccines.gov, www.cdc.gov, www.who.int, www.immune.org.nz, www.technologynetworks.com, www.biology.arizona.edu,

Catalysed and supported by
Department of Science & Technology
Government of India
रविप्रीसंप NCSTC
Developed by
VIKRAM A SARABHAI COMMUNITY SCIENCE CENTRE

COVID-19 Science Outreach

ANTIGEN DETECTION TESTS

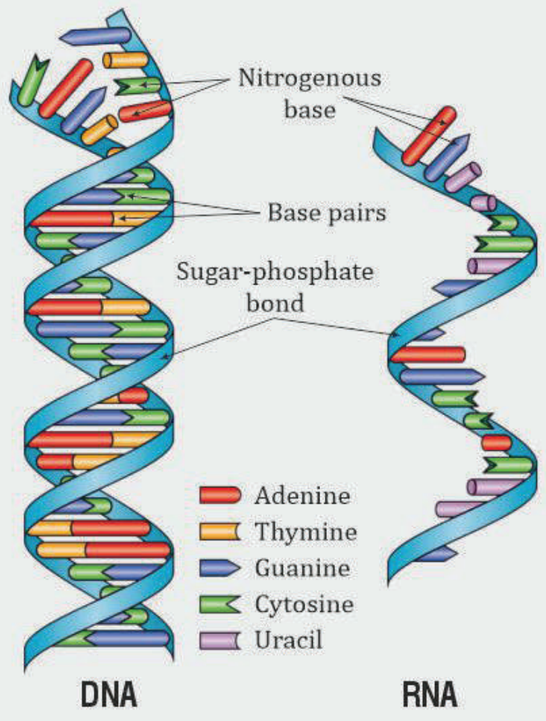
Detection of COVID-19 antigen is based on molecular techniques like Reverse Transcription Polymerase Chain Reaction (RT-PCR) & Rapid Antigen Test. These scientific techniques involve the study of antigen or DNA / RNA isolated from a cell.

DNA *Deoxyribonucleic acid*

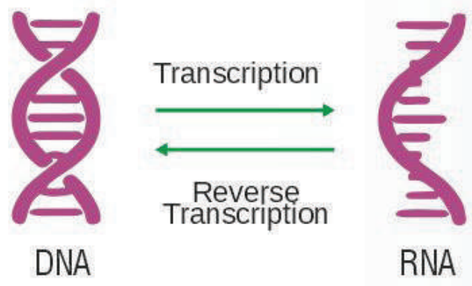
It is a molecule that humans and most organisms use to store information in form of genetic code. It is formed from two strands that bind together forming a helix shape.

RNA *Ribonucleic acid*

In humans, RNA's main function is to covert information stored in DNA to proteins. Some viruses use RNA instead of DNA to store their genetic code, including the SARS-CoV-2.



Viral Load
It is the measure of total number of viral particles inside the individual. High viral load indicates that replication of virus in the cells is at higher rate.

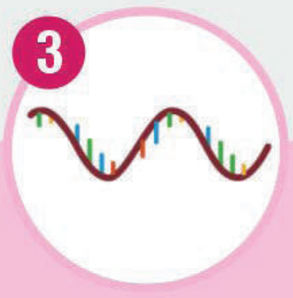


Transcription is the process where information in DNA is synthesized into RNA. While in reverse transcription, it is opposite.

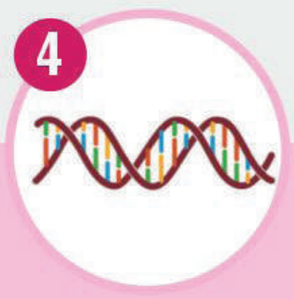
RT-PCR Test

1 A small piece of gauze / absorbent material attached to a stick (swab) is used for collecting samples.

2 Sample is treated with chemicals & enzymes that remove proteins, fats & other molecules, leaving RNA intact.

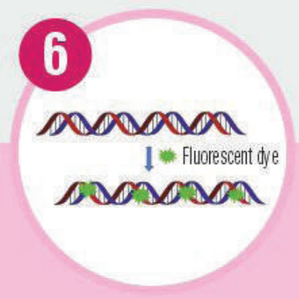


3 This purified RNA is mixture of a person's genetic material & viral RNA (if present).



4 The enzyme Reverse Transcriptase converts the RNA into DNA .

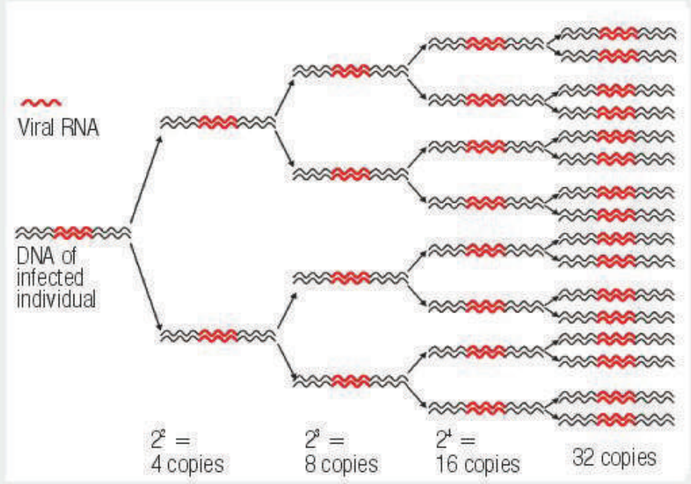
5 DNA along with other chemicals and fluorescent dyes are added in PCR machine.



6 New identical copies of DNA are created. Dyes bind to DNA as it gets copied.

Result
The amount of light produced by fluorescent dye equals to amount of virus present.

High intensity of light (fluorescence) → more amount of virus

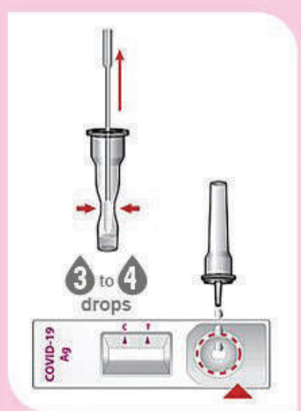


New identical copies of DNA created in PCR machine

Rapid Antigen Test

Nasopharyngeal/ oropharyngeal sterile swab collection

Insert collected swab sample in extraction buffer tube. Mix swab well with extraction buffer. Press the nozzle on the cap to cover it.

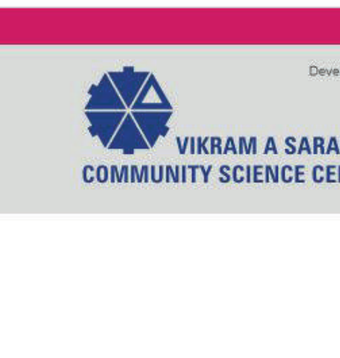


Add 3-4 drops of solution in the sample well of the casette.

Read the test result in 15-20 minutes.

CAUTION The test result after 20 minutes may give false results.

Result
This test detects the coronavirus (antigen). The control line, regardless of positive or negative result will display colour change.



Precautionary measures

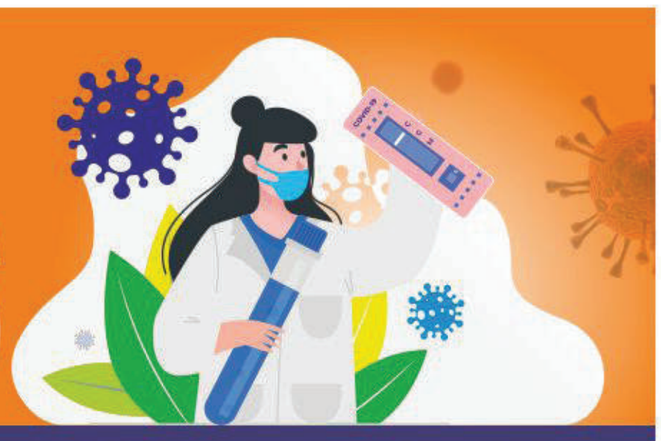
If sample is taken in early or late phase of infection, the results will be negative. Distribution of virus across respiratory tract varies from person to person. The virus may only be detectable in sputum or nasopharyngeal swab but not necessarily at both locations at the same time.
Most COVID-19 Rapid Antigen Test kits are stored between 15° C to 30° C & out of direct sunlight.
RT-PCR kits are generally stored at –20°C in a laboratory (temperature constant) freezer and protected from direct sunlight.

References: www.cebm.net, www.iaea.org, www.biopanda.co.uk, www.who.int, www.cdc.gov, www.genesinspace.org, www.courses.lumenlearning.com

Catalysed and supported by
Department of Science & Technology
Government of India
राविप्रीसंप NCSTC
Developed by
VIKRAM A SARABHAI COMMUNITY SCIENCE CENTRE

COVID-19 Science Outreach

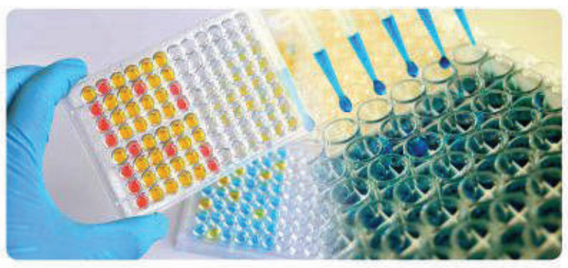
ANTIBODY DETECTION TESTS



The immune system of person infected by SARS-CoV-2 will produce Immunoglobulin M (IgM) and Immunoglobulin G (IgG) antibodies to fight against it. The IgM antibodies are produced in 4-7 days while IgG antibodies are produced between 10-14 days. The antibody test detects the antibodies to the virus and not the virus. The molecular tests for detecting these antibodies are Enzyme linked Immunosorbent Assay (ELISA) and Lateral Flow Antibody Immunoassay.

Antibody tests are critical for assessing spread of the virus and the level of 'herd' immunity in the population. These tests can also identify asymptomatic people who are 'carriers' or 'silent spreaders' of the infection.

ELISA Antibody Test

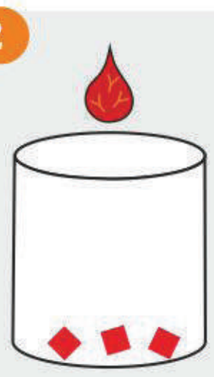


ELISA test is performed on 96 well plates, commonly known as ELISA plates or microtiter plates. They are flat-bottomed and made from polystyrene or polyvinyl chloride.

1

This is one of the wells of ELISA plate. Antigen specific to SARS-CoV-2 (in red) is coated at the bottom of the well.

2

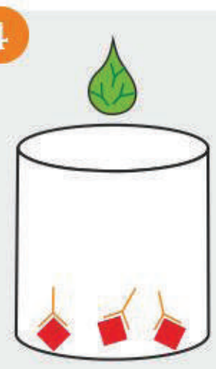


Patient's blood or serum sample (which may contain antibodies to SARS-CoV-2) is added to the well.

3

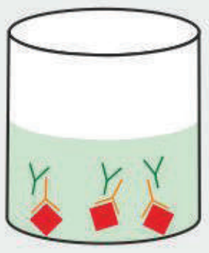
If sample has antibodies to SARS-CoV-2, it will form Ag-Ab complex. Extra components are washed out.

4



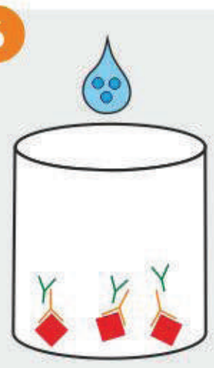
Laboratory-produced antibodies and enzymes are added.

5



These antibodies attach to the Ag-Ab complex and form a second layer. Excess antibody is washed out.

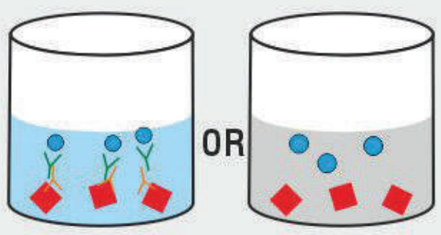
6



Special chemicals are added which will react with the Ag-Ab complex to initiate colour change.

7

Colour change indicates
+ve result → Ab present



OR

No colour change indicates
-ve result → Ab absent

Result

A positive result indicates that sample has antibodies to SARS-CoV-2 virus. Colour change (positive result) can be viewed with unaided eyes & ELISA reader machine is used for quantification.

ELISA plate reader machine

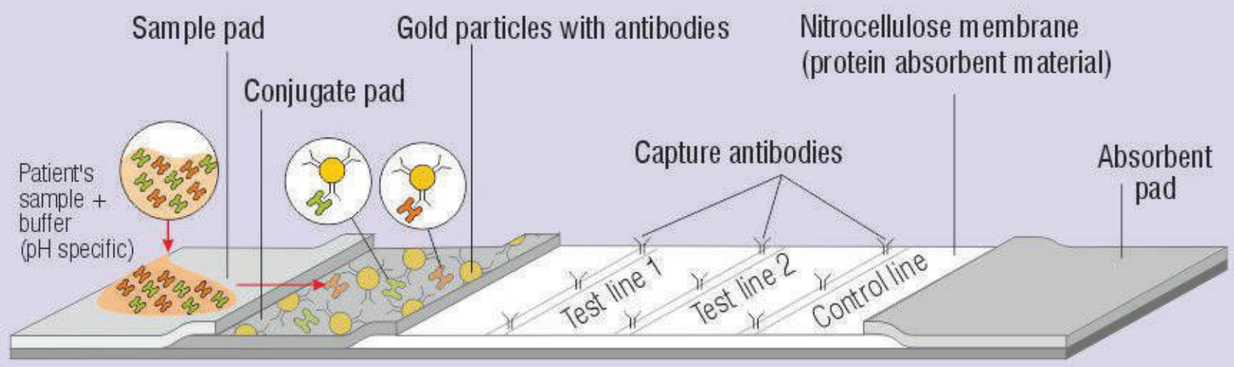
*Depending upon kit used, steps may vary.

ELISA Antibody test kits are generally stored at a temperature between 2°C and 8°C.

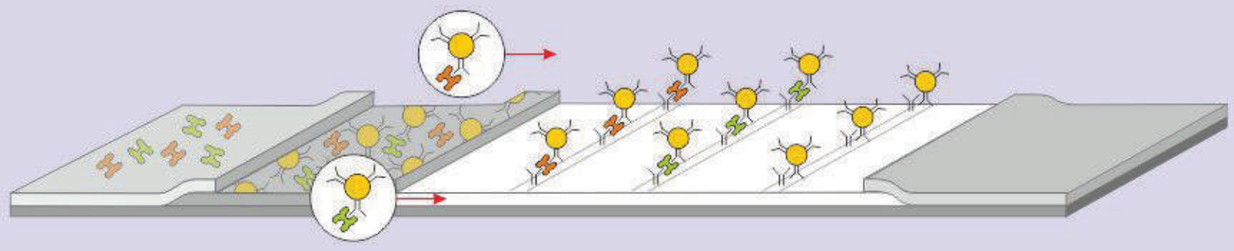
Lateral Flow Antibody Immunoassay

An immunochromatographic assay

A drop of patient's blood (from prick on middle or index finger) / plasma / serum can be used as sample. In each cassette/stick, there is a control antibody with colloidal gold marker. This test is also known as 'Colloidal Gold Immunochromatography'. Control labels can be carbon or latex depending upon the type of test.



The sample & buffer moves along the membrane through capillary force. If antibodies IgG or IgM against SARS-CoV-2 are present in the sample and they bind with gold plated antibody on conjugate pad.

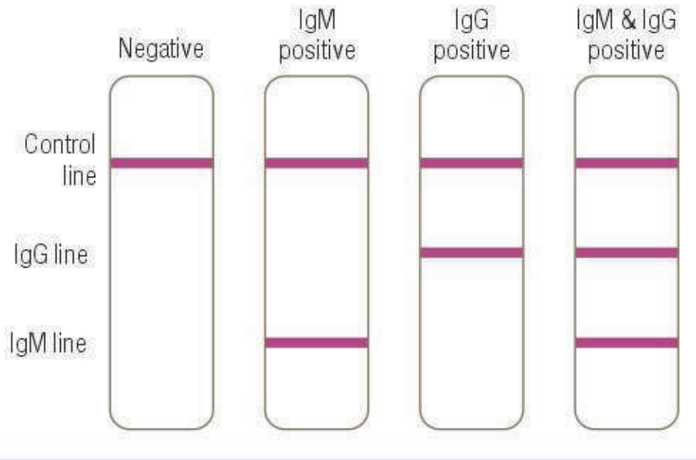


In presence of SARS-CoV-2 IgG or IgM antibodies, an IgG-IgG/ IgM-IgM complex will be formed, resulting in colour change on test lines (observed in form of pink line).

*The test kit is to be used by authorized laboratory personnel only.

Result

This test detects antibodies IgG and IgM alone or both together. The control line, regardless of positive or negative result will display colour change.



Most SARS-CoV-2 Antibody test kits are stored between 2°C- 30°C.

Limitations

ELISA test sometimes gives positive result for unrelated proteins. A positive test result must be reconfirmed by another method.

The Immunoassay is for qualitative testing. For further studies, quantitative methods should be used. Negative results may be due to low concentration of antibodies, difference in temperature and humidity.

References: www.nature.com, www.cebm.net, www.ncbi.nlm.nih.gov, www.britannica.com, www.soinc.org, academic.oup.com

Catalysed and supported by
Department of Science & Technology
Government of India
रविप्रीसंप NCSTC

Developed by
VIKRAM A SARABHAI COMMUNITY SCIENCE CENTRE

COVID-19 Science Outreach

VACCINES

A vaccine helps the body's immune system to recognize and fight pathogens like harmful virus or bacteria and keeps us safe from the diseases they cause. Vaccines have protected people against more than 25 life-threatening diseases. Different types of vaccines work in different ways to offer protection. The vaccines help to produce adaptive immune response and 'immunological memory' against the pathogen.

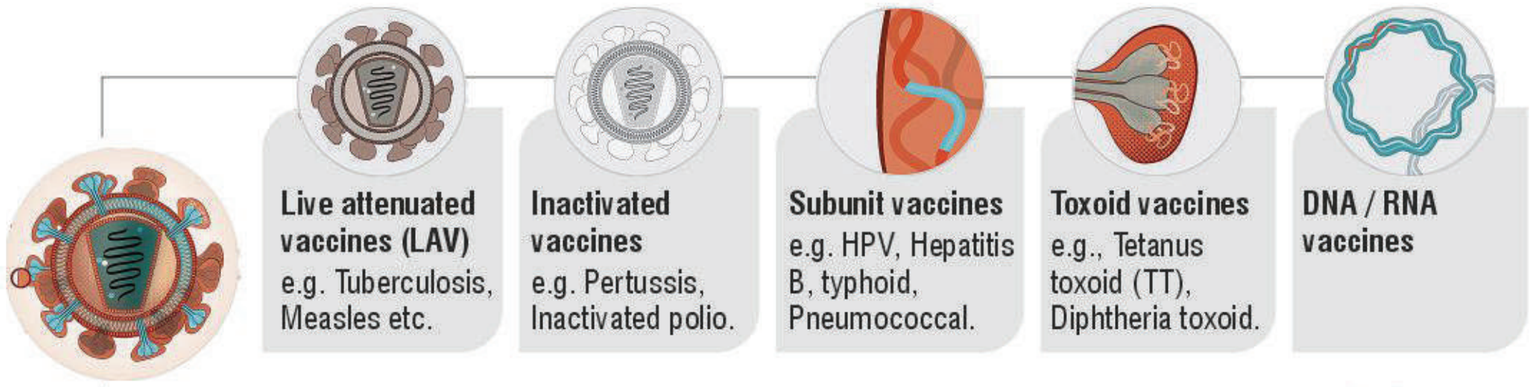
Monovalent vaccine - Single strain of a single antigen (e.g. Measles)

Polyvalent vaccine - Two or more strains of same antigen (e.g. OPV; Oral Poliovirus Vaccine)

Combination vaccines - Two or more strains of different antigen (e.g. MMR; Measles, Mumps, Rubella).

Vaccination - Process of introducing vaccine in an individual to produce immunity against specific disease.

Immunization - A process by which a person becomes protected against a disease through vaccination.



Live attenuated vaccines (LAV)
e.g. Tuberculosis, Measles etc.

Inactivated vaccines
e.g. Pertussis, Inactivated polio.

Subunit vaccines
e.g. HPV, Hepatitis B, typhoid, Pneumococcal.

Toxoid vaccines
e.g., Tetanus toxoid (TT), Diphtheria toxoid.

DNA / RNA vaccines

Recombinant vaccines
Platform-based vaccines act like a natural infection to produce immune response.

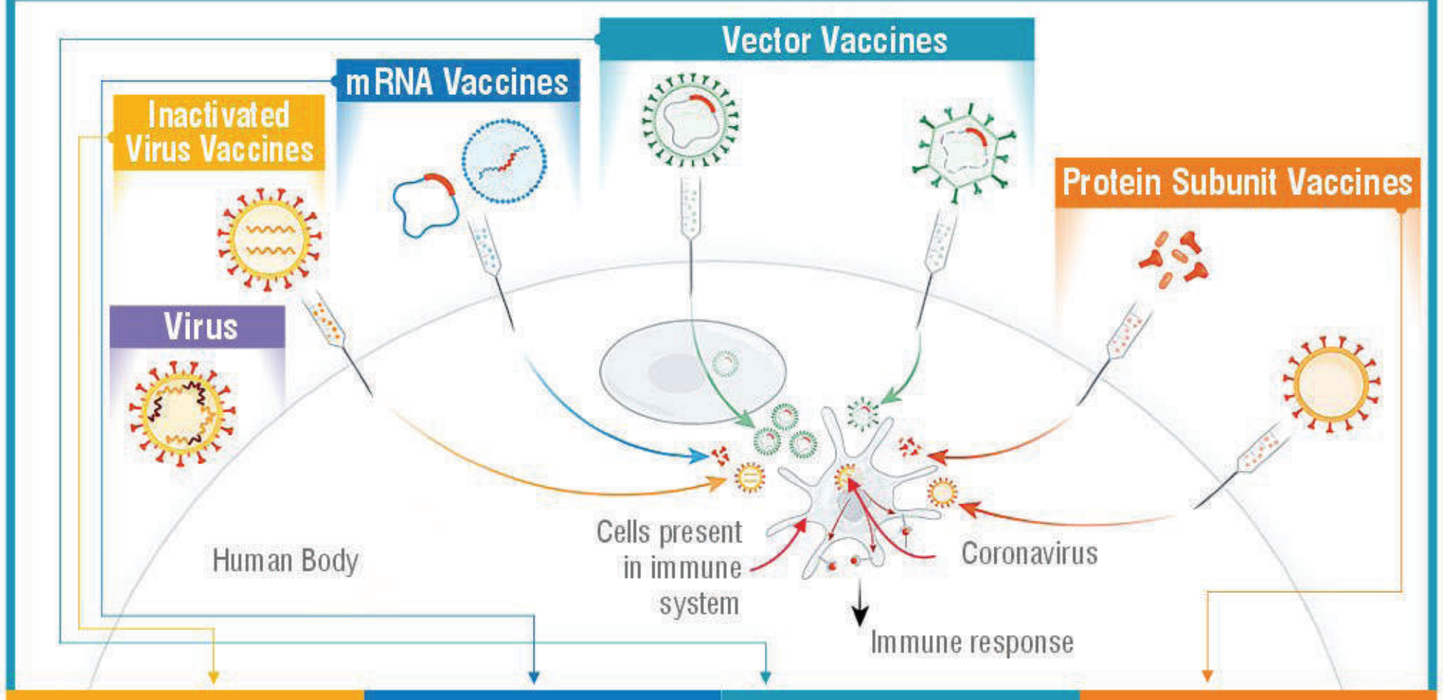
Recombinant Viral Vector

Recombinant Bacterial Vector

Recombinant Sub-unit

Components of a vaccine : Antigens, Stabilizers, Adjuvants, Antibiotics, Preservatives

Potential COVID-19 vaccines



Inactivated / weakened virus vaccines
Virus does not cause disease but generates immune response.

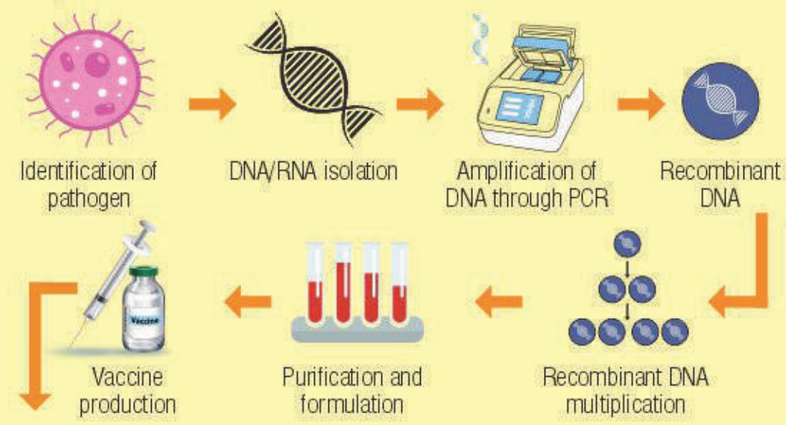
mRNA vaccines
Genetically modified RNA or DNA generate protein to trigger immune response.

Vector vaccines
Virus, genetically engineered, produces coronavirus proteins to generate immune response.

Protein subunit vaccines
Harmless fragments of proteins mimic COVID-19 virus, to trigger immune response.

Stages Of Vaccine Development

Exploratory and clinical stage
This stage is pre-clinical laboratory research which involves *in vitro* & *in vivo* analysis.



Approval for clinical trial from **CDSCO** (Central Drugs Standard Control Organization), Govt. of India.

Phase I trial
The first trial to assess the effect of vaccine in group of 20-80 adult human volunteers.

Phase II trial
If the first trial is successful, the second trail involves hundreds of individuals.

Phase III trial
After successful completion of second trial, the vaccine is tested on thousands of individuals.

After successful completion of phase III trial, the application is sent for getting license.

All the research, data and results of vaccine development are presented for review at CDSCO.

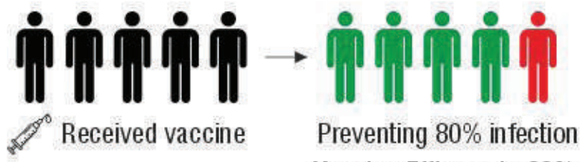
CDSCO

Once the vaccine is approved from the committee, CDSCO provides the license.

The vaccine is then available for all individuals.

Phase IV trial
These trails begin after the vaccine is released for immunization to these studies continuously check vaccine's safety, efficacy etc.

Vaccine efficacy
Natural infection or vaccination do not always provide lifelong immunity. Vaccination is scheduled when individuals are most susceptible to get vaccine-preventable disease. No vaccine is 100% effective, some people are not immune even after vaccination while for many the 'immunological memory' decreases over a period of time.



Vaccine storage depends upon its type. DTap or Covishield vaccines have to be stored between 2 to 8°C while chickenpox vaccines have to be stored between -50 to -8°C.

Vaccine Effectiveness is measured with regularly assessing and confirming the effectiveness of a vaccine on people with co-morbid conditions under real world conditions.

Booster Dose: An additional dose of a vaccine needed to increase the body's immunity to a particular disease at a time when the effective initial vaccine may start to wear off. e.g., Tetanus & diphtheria vaccine is recommended for adults every 10 years.

References: www.immune.org.nz, www.cdc.gov, www.medicinenet.com, www.who.int, www.vaccines.gov, www.cdc.gov, www.clinmedjournals.org, www.cmr.asm.org/, www.ncbi.nlm.nih.gov, www.biology.arizona.edu

Catalysed and supported by
Department of Science & Technology
Government of India
रविप्रीसंप NCSTC

Developed by
VIKRAM A SARABHAI COMMUNITY SCIENCE CENTRE

COVID-19 Science Outreach

ANTIMICROBIALS

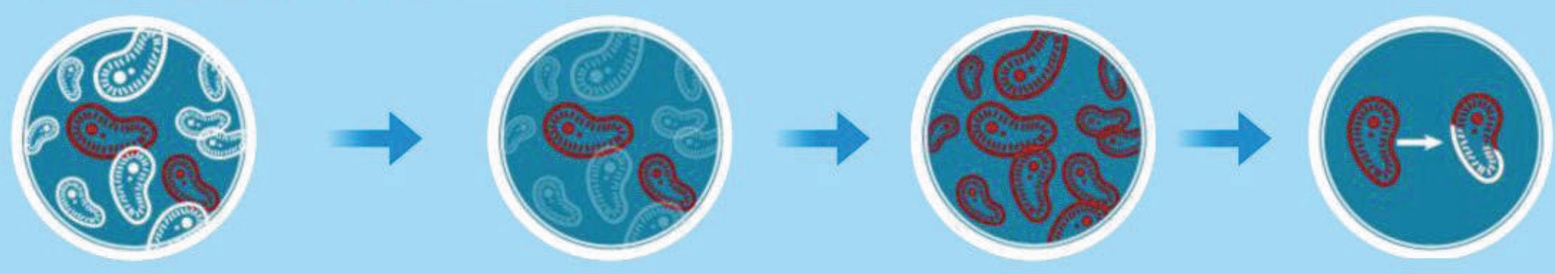
Antimicrobials are used for treatment when an individual gets infected by bacteria, virus, parasite or fungus. Most antimicrobials are easily available, cost effective and safe to use. But, the overuse and misuse of antimicrobials have resulted in microbes which are resistant to them leading to loss of their efficacy. There are four types of antimicrobials: antibiotics, antivirals, antiparasitics and antifungals.

Antibiotics or Antibacterials

Antibiotics can cure many types of bacterial infections. They either kill the bacteria or stop them from replicating. It is advisable to take antibiotics as prescribed by the doctor. Even after symptoms disappear, the course of antibiotic should be completed as it prevents the development of resistant bacteria. An antibiotic can cure many bacterial infections of wide range. But, they don't work against viral infections like flu or common cold.

Bacteria are highly adaptable organisms and over use or misuse of antibiotics will make bacteria resistant to it. e.g. penicillin.

How does antibiotic resistance occur?



There are many types of bacteria in our body and very few are resistant to antibiotics.

When antibiotics kill the harmful bacteria, they also kill some of the good bacteria which protect the body. The antibiotic-resistant bacteria remain unaffected.

These antibiotic-resistant bacteria then grow and multiply.

Some antibiotic resistant bacteria transfer their resistance ability to other bacteria.

The last new class of antibiotics to be approved was daptomycin which was discovered in 1987.

Penicillin *An accidental discovery*

In 1928, Alexander Fleming noted that in his petridish containing culture of *Staphylococcus* bacteria, there was growth of blue-green mold called *Penicillium notatum*. There was a clear ring surrounding the mold with no bacterial growth on it. In this way, first antibiotic was discovered. After further research, penicillin antibiotic was made available to individuals in 1942.

Drug and Medicine *Thin line of difference*

Drug is a substance that affects how the body works. It can include medicines or nicotine.

Drugs can be harmful or helpful.

Medicine is a drug used for treatment, diagnosis or prevention of a disease.

All medicines are drugs but not all drugs can be medicines.

Antivirals

Antiviral drugs are available in pills, liquid, powder or as intravenous liquid. These drugs are more difficult to develop as compared to antibiotics.

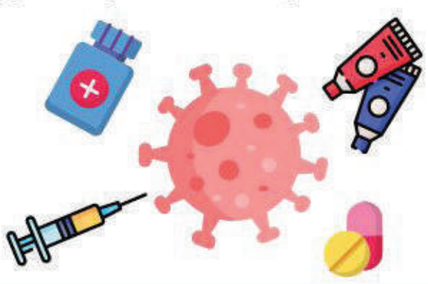
An antibiotic can treat many bacterial infections, an antiviral drug cannot do the same. An antiviral drug is specific to specific to viral infection. A few antiviral drugs available are for influenza, HIV, herpes, and hepatitis B and C.

Like bacteria, viruses also mutate over time and develop resistance to antiviral drugs.

Virus particles multiply inside the body

Antiviral drugs act by:

- Inhibiting a virus's ability to reproduce
- Enter the cell infected with virus
- Interfere with host binding ability of virus
- Trigger body's immune system for activation.



Nanotechnology & Medicines

Research is going on for using nanoparticles as medicines. Nanoparticles will be used to deliver drugs, heat, light or other substances to specific types of cells (like cancer cells). The particles (nanomedicines) are engineered in such a way that they become attracted to the diseased cells and then directly treats them. This technique reduces damage to healthy cells in the body and allows for earlier detection of disease.

Vaccines help to develop immunity against the disease without getting the disease first. Medicines treat or cure the disease.

Antifungals

Also known as an antimycotic medication or fungicide or fungistatic, they are used to treat and prevent mycosis or fungal infections such as athlete's foot, ringworm, candidiasis, serious systemic infections such as cryptococcal meningitis etc.

Antiparasitics

Antiparasitics are used for treatment of parasitic diseases, such as those caused by helminths, amoeba, ectoparasites, parasitic fungi and protozoa and many more. Examples of parasitic infections are stomach & gut worms (threadworm, hookworm), skin mites (scabies), hair & body lice (head lice and crab lice), malaria (female anopheles mosquito).

What are Superbugs?

Microorganisms which becomes resistant to the drug that is used for their treatment are called superbugs. Certain bacteria and fungi are called superbugs because they infect humans, animals and crops more as compared to other microorganisms. The term 'superbug' was coined by the media. In scientific terminology it is referred to as 'Multidrug-Resistant' (MDR) infectious organism.

References: www.ncbi.nlm.nih.gov, www.medicalnewstoday.com, www.cmr.asm.org, www.needtoknow.nas.edu/id/prevention/vaccines-medicines/antibiotics-and-antivirals, www.clinmedjournals.org, www.bbc.com, www. newz.ug, www1.health.gov.au

Catalysed and supported by
Department of Science & Technology
Government of India
रविप्रीसंप NCSTC
Developed by
VIKRAM A SARABHAI
COMMUNITY SCIENCE CENTRE