

Microorganisms: Friend and Foe



SCINDIA KANYA
VIDYALAYA
Affiliated to C.B.S.E.

Sita & her Secret World of Microbes

GRAPHIC NOVEL



Published by

SCINDIA KANYA VIDYALAYA

Moti Mahal Road, Lashkar, Gwalior,
Madhya Pradesh – 474009

(Affiliated to C.B.S.E.)

ACKNOWLEDGEMENT

This graphic novel is developed with the intent to make learning process experiential and student friendly. It is the result of beautiful integration of Art, Science, English (language) and Computer Graphics. The valuable suggestions received, time to time from the faculty members are duly acknowledged. The contribution of Ojaswi Mehta, one of our students in the form of diagrams is highly appreciated. We would like to thank all those who have immensely contributed to the production of this book.

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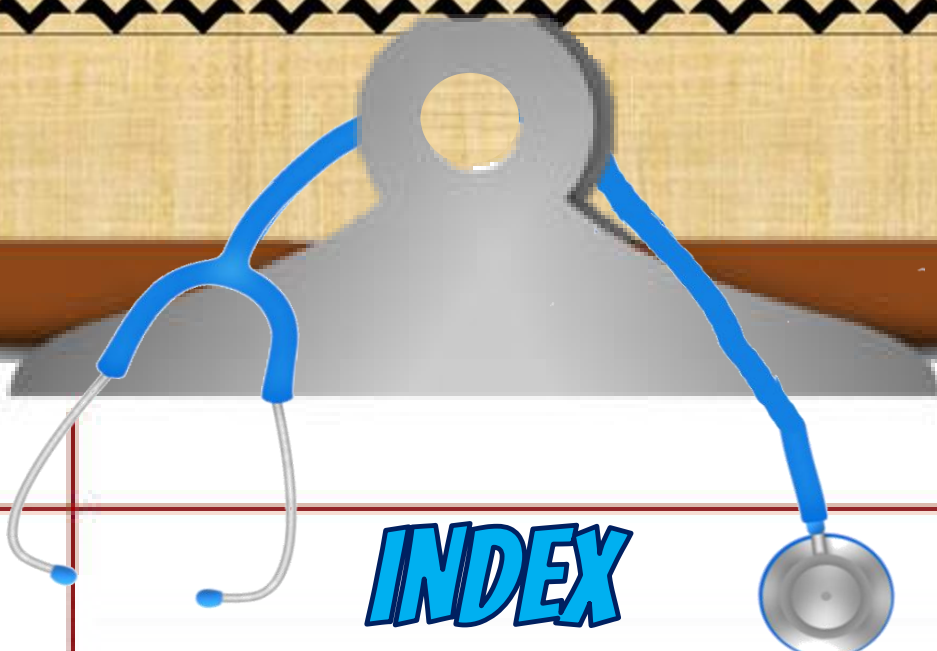
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PREFACE

This graphic novel is based on the chapter entitled “**Microorganisms: Friends and Foe**” from Class VIII NCERT Science textbook. The primary objective is to present the Microbial World in a creative and engaging manner. Relevant day to day experiences are mentioned for better understanding.

The learning outcomes covered in this novel map with all the learning outcomes of class VIII Science chapter - Microorganisms: Friend and Foe. This novel will be helpful to the students of classes IX to XII. It partly covers learning outcomes of class IX Science chapter “Why do we fall ill?” and also maps with some learning outcomes of class XII Biology chapters – “Human Health and Diseases” and “Microbes in Human Welfare”, as per NCERT curriculum.

The central character of this graphic novel is a 12 year old girl who is curious, inquisitive and analytical by nature. She learns about the tiny organisms which cannot be seen by naked eyes, through her interaction with the doctor, her teacher and her parents.

She learns about viruses and bacteria and about some diseases they cause. She is also introduced to the working of defense system of human body. In the process, she learns about three pioneers – Ronald Ross, Edward Jenner and Alexander Fleming whose contributions have saved many lives.

This graphic novel is an attempt to make learning enjoyable and lasting.



0854CH02



LEARNING OUTCOMES

To access the comic book and additional interactive digital content, download DIKSHA app from Google Play Store on your android smart phone or tablet

On reading this graphic novel, students will acquire the knowledge and understanding of:

- 1. Viruses*
- 2. Micro-organisms and their types - bacteria, protozoa, fungi and algae*
- 3. Uses and harms of micro-organisms*
- 4. Diseases caused by micro-organisms*
- 5. Our body's defense system*
- 6. Principle of vaccination (story of Edward Jenner)*
- 7. Discovery of Antibiotics (story of Alexander Fleming)*
- 8. Preservation of Food*





CAST OF CHARACTERS

1. Sita : an intelligent child with an inquiring mind, curious about the unseen world of microbes

2. The Gupta family :

Sita's grand father : Mr. Shankar Gupta

Sita's father : Mr. Ravi Gupta

Sita's mother : Mrs. Shalu Gupta

Sita's brother : Sonu

(Sita's family members are very supportive of their daughter's quest to learn new things.)

Supporting characters :

1. Dr. Pallavi Sharma : A friendly doctor who launches Sita on her quest

2. A supportive teacher who encourages her to go further in seeking knowledge of microbes

3. A domestic help

Characters from history :

1. Ronald Ross

2. Alexander Fleming

3. Edward Jenner

PROLOGUE

October 25, 2055.

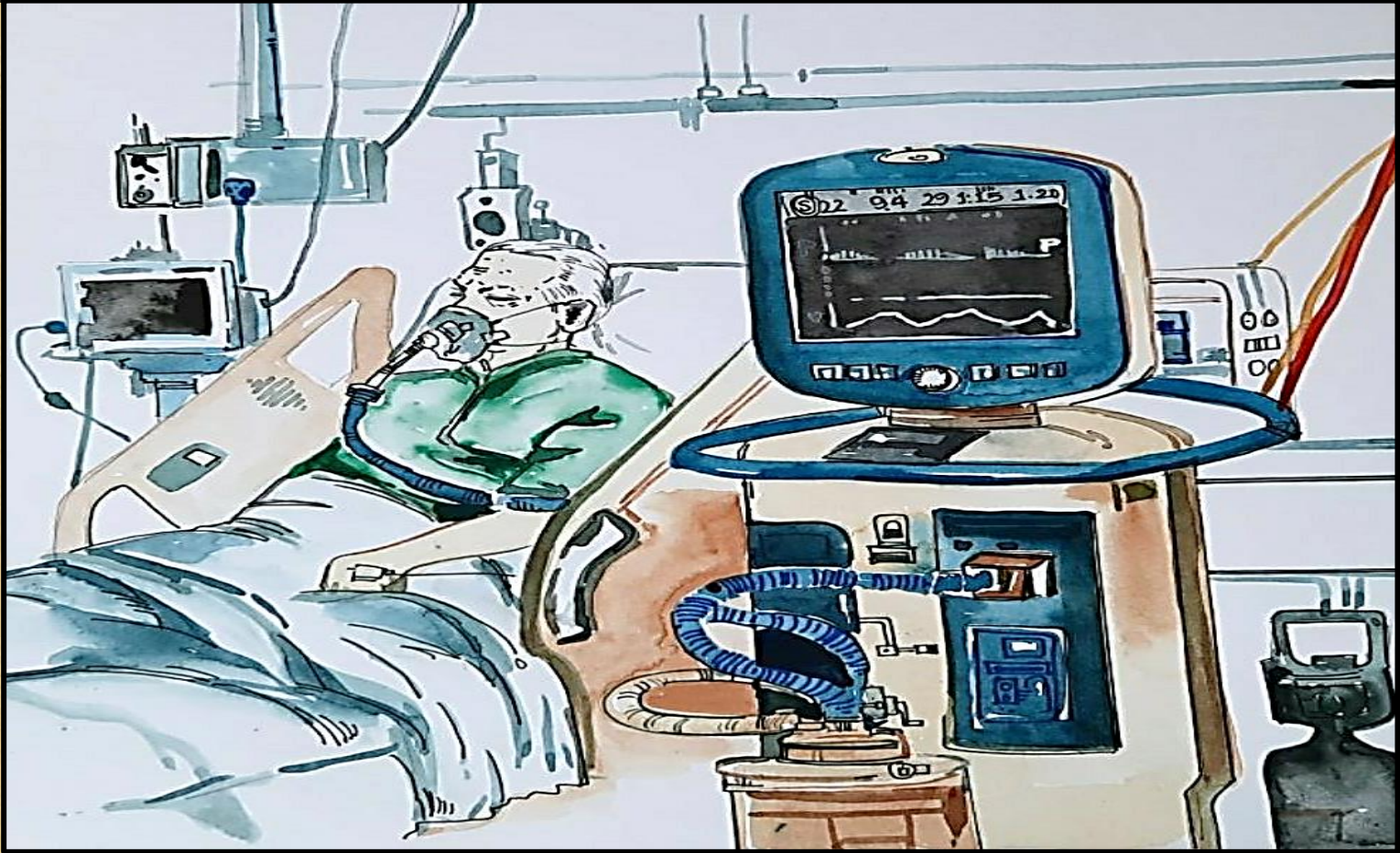
Renowned Scientist Dr. Sita Gupta is honoured with a prestigious Award. She shares her childhood experiences



CHAPTER 1

SITA LEARNS ABOUT VIRUS AND THE BODY'S DEFENSE SYSTEM

FLASHBACK.....On Friday, 27th March 2020, at Apollo Hospital....



Mr. Gupta, a recent victim of Covid-19 pandemic



The Gupta family waits anxiously.....

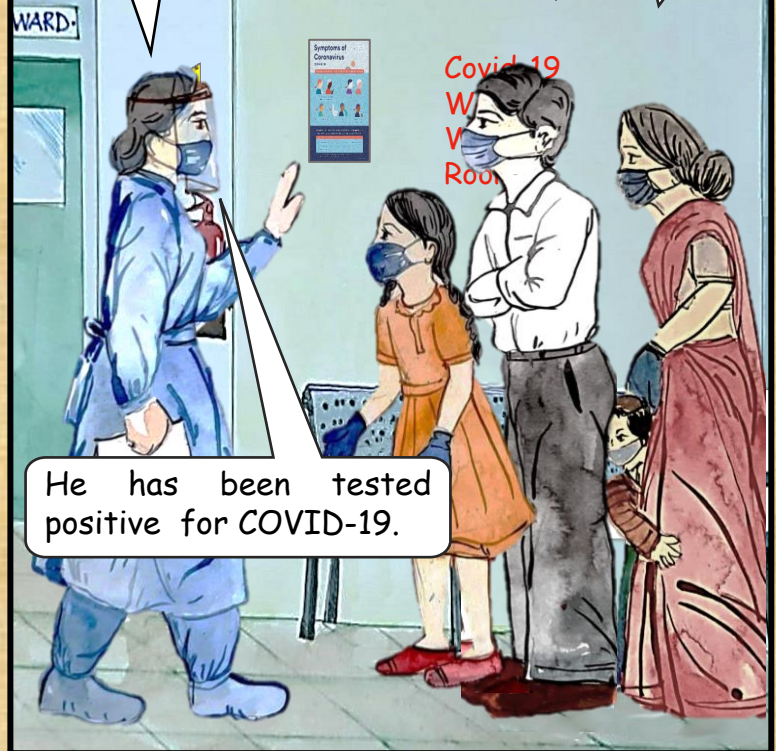


Dr. Pallavi Sharma approaches ...



Mr. Gupta has stabilized.
Nothing to worry.

Thank God !!



Covid-19.
What is that?

Covid-19 is a disease caused
by virus. A virus is an enemy
of living beings. It is a very
tiny infectious agent.



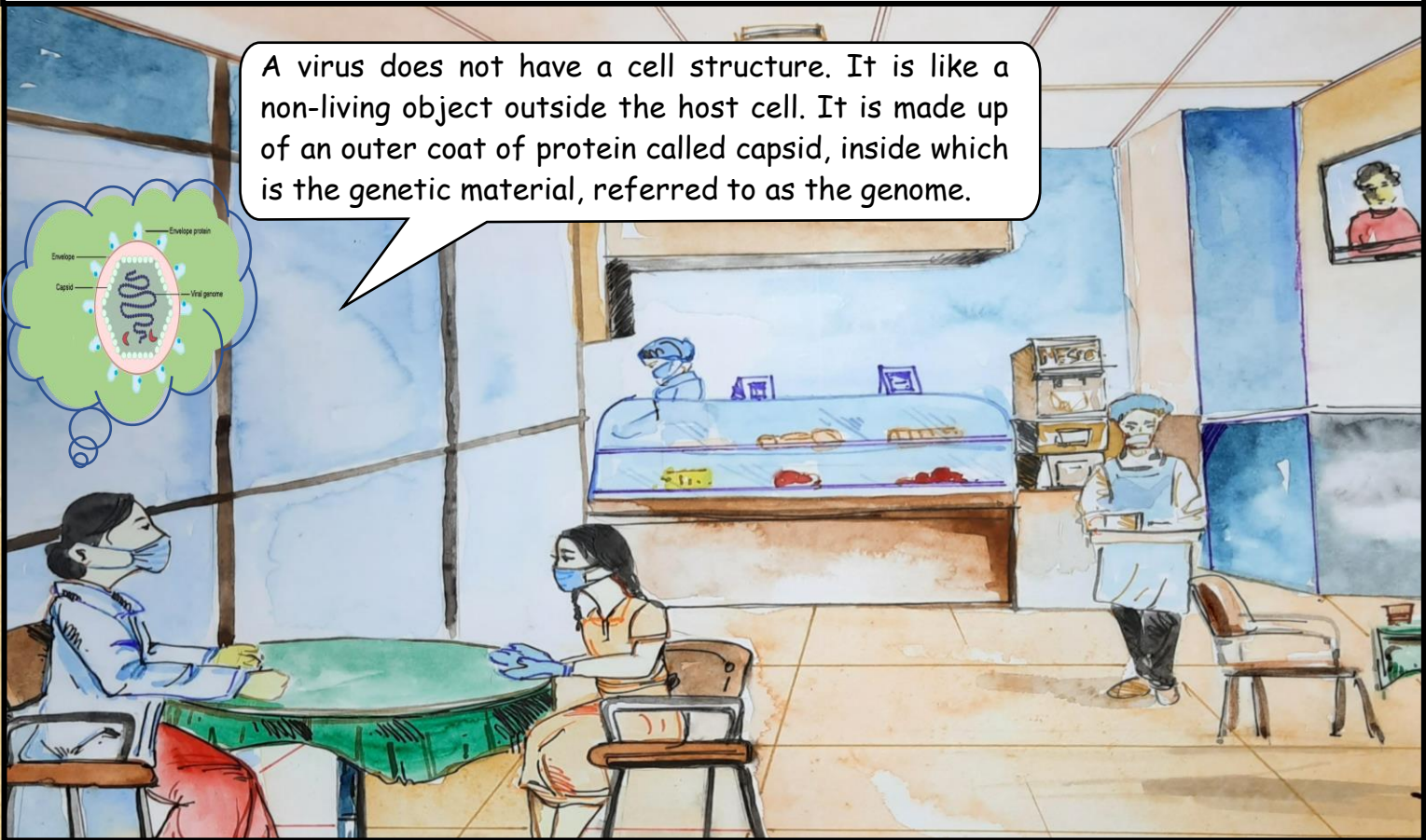
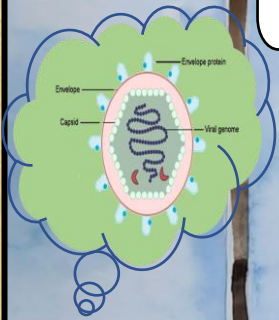
Could you
tell me
more about
this enemy,
Doctor?

Sure, meet me in the
hospital canteen in 10
minutes, but first sanitize
your hands and keep your
mask on as corona virus
spread through respiratory
droplets.



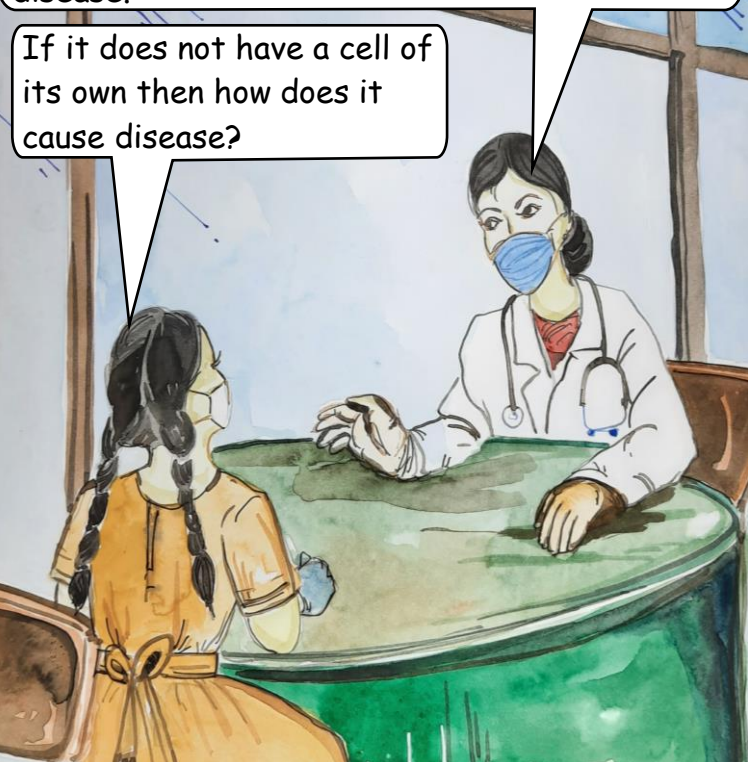
Ten minutes later, in the hospital canteen.

A virus does not have a cell structure. It is like a non-living object outside the host cell. It is made up of an outer coat of protein called capsid, inside which is the genetic material, referred to as the genome.



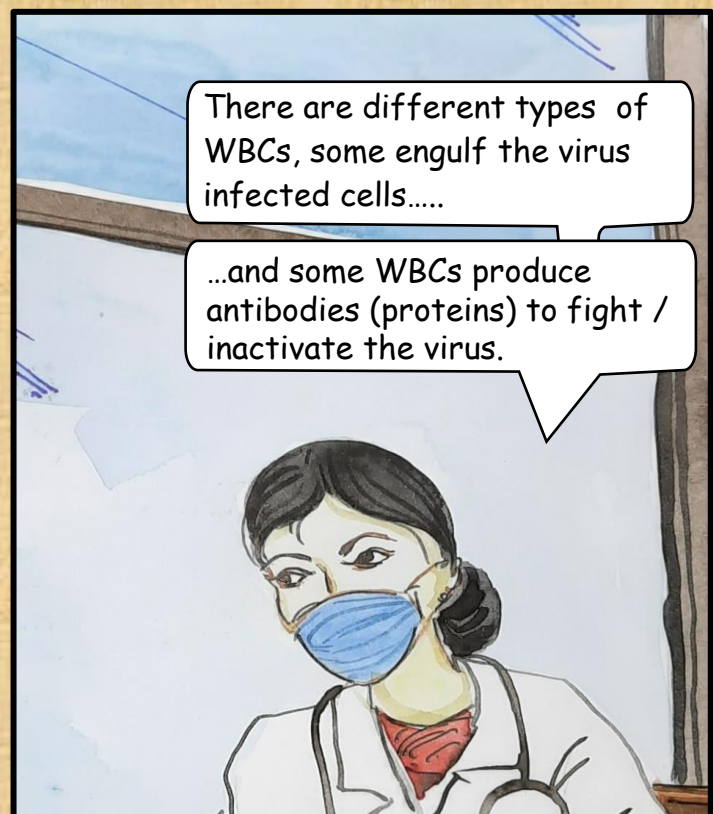
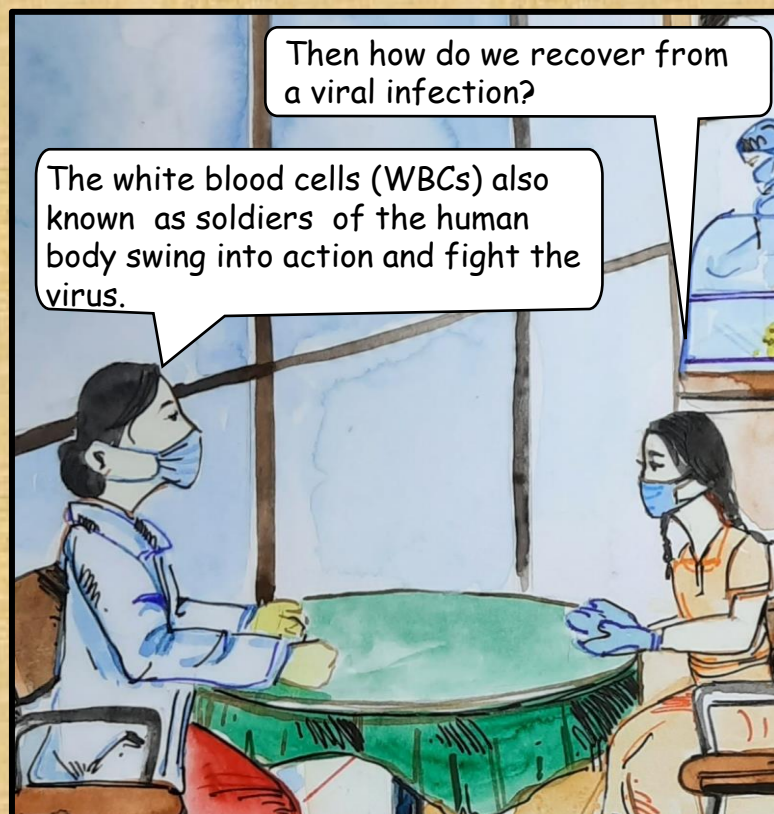
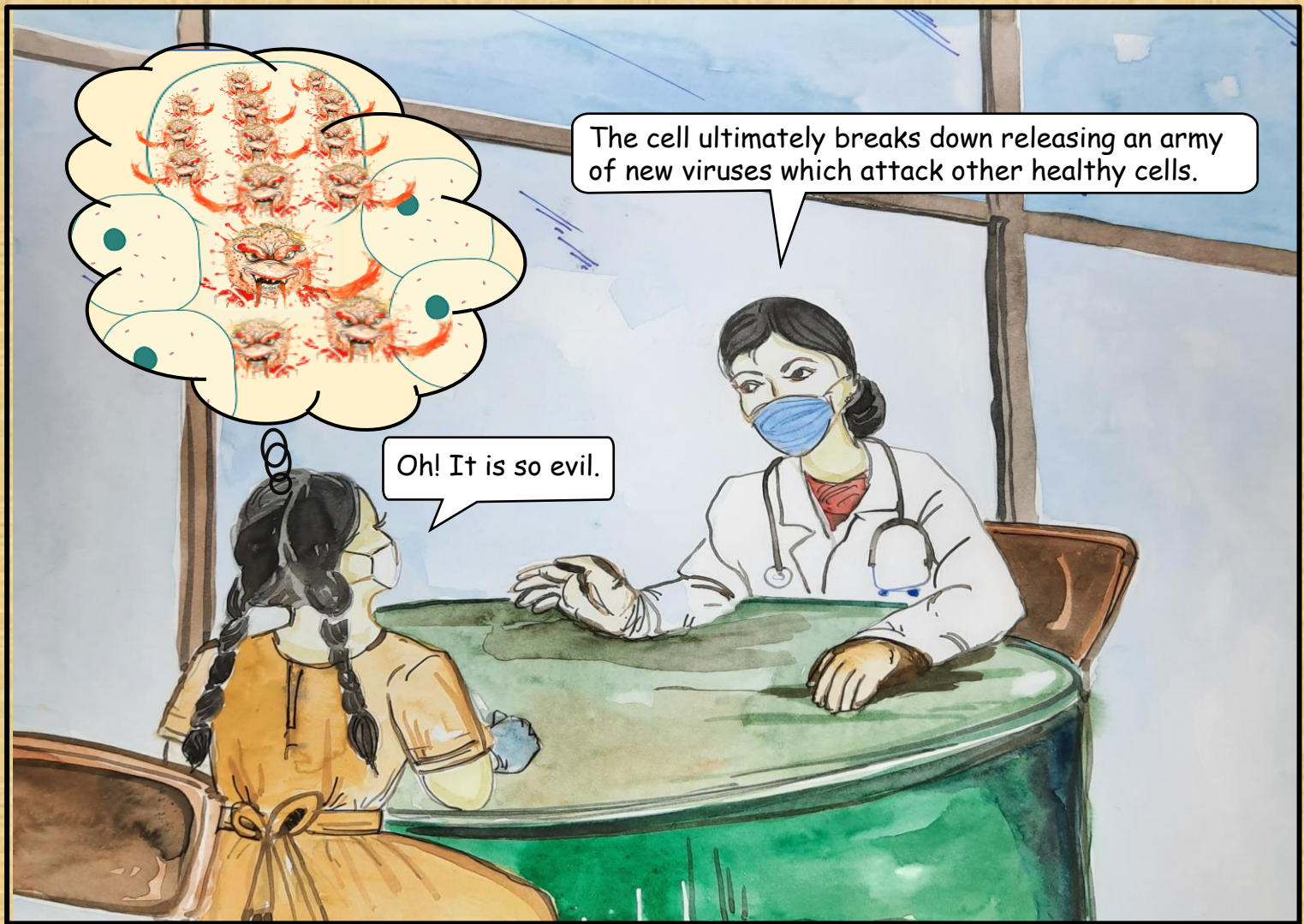
There are different types of viruses. Each infects a specific cell, which may be a bacterial cell, plant cell or an animal cell and it causes disease.

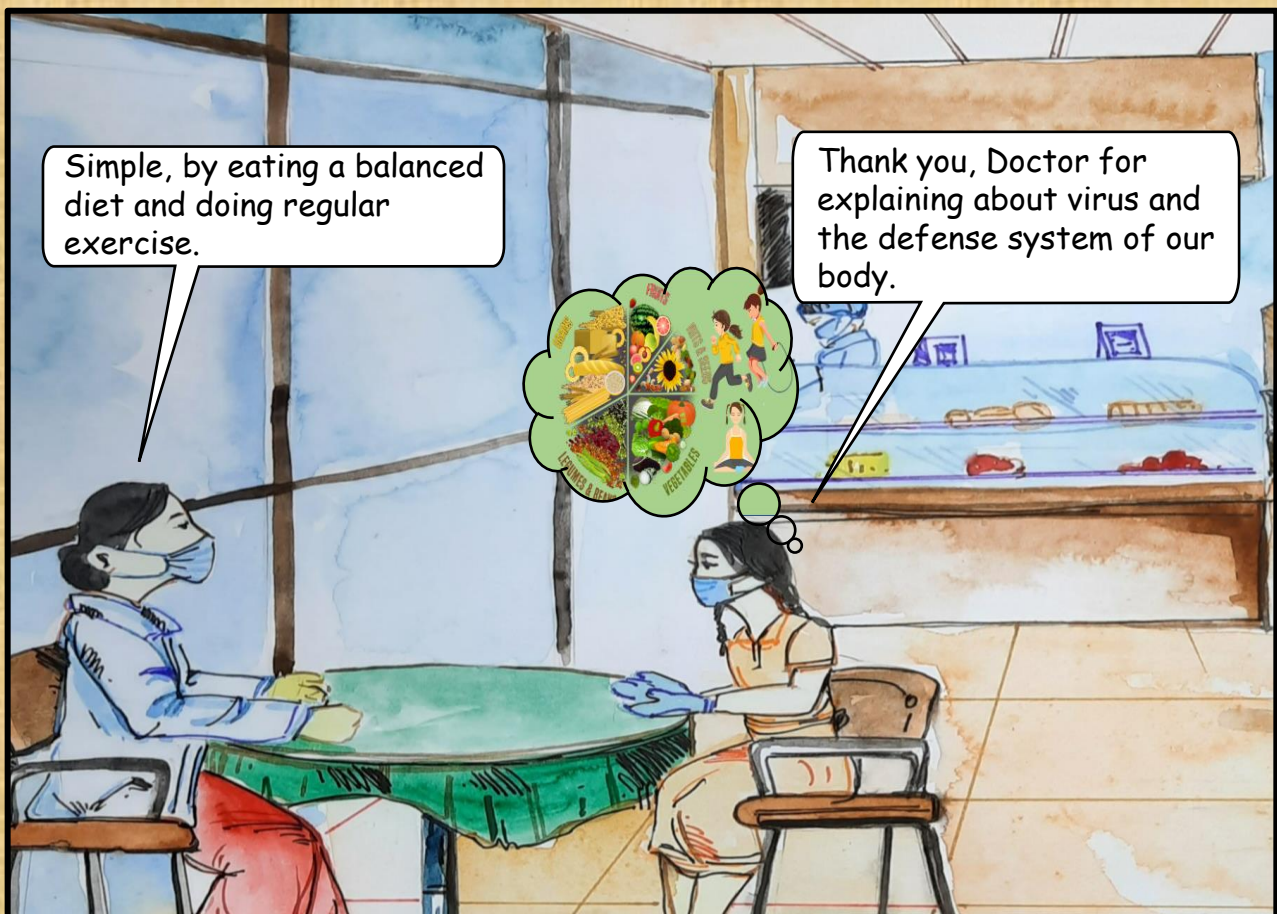
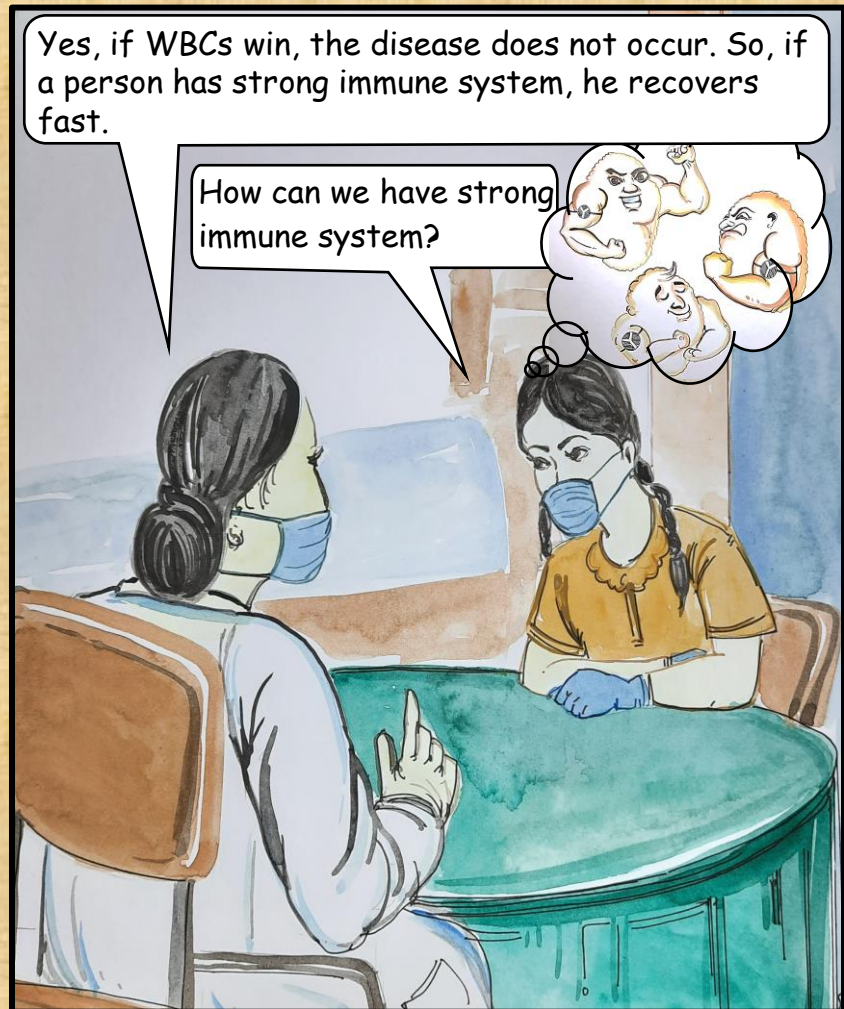
If it does not have a cell of its own then how does it cause disease?



A virus enters a host cell and takes charge of the cell and uses cellular resources and machinery to multiply itself.







Check your understanding

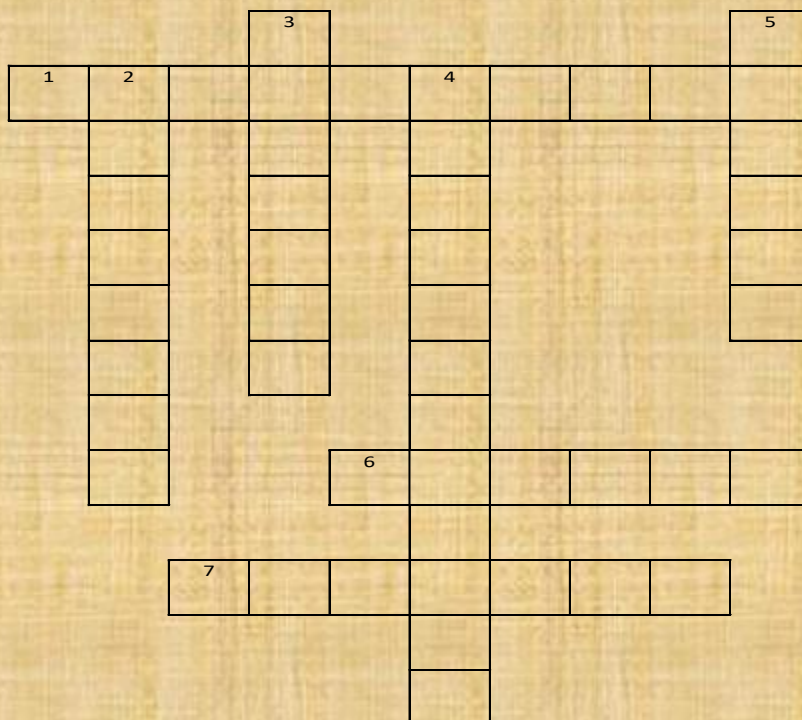


Fill in the blanks with the correct option.

1. Covid-19 is caused by _____. (bacteria / virus)
2. Virus is made up of _____ and _____. (cell/ proteins/ genome/ sugar)
3. Virus has cell structure. _____ (True / False)
4. Virus that infects plants can infect bacteria. _____ (True / False)
5. _____ in the human body fights viruses. (white blood cells/ red blood cells)
6. Antibodies are proteins made by _____. (red blood cells / white blood cells)
7. Virus uses the resources from the _____ to multiply itself. (environment / host cell)
8. Virus can be seen by naked eyes _____. (True / False)



Solve the crossword puzzle



Across

1. An instrument used to see very tiny objects
6. The term given to the outer part of the virus
7. A virus that caused pandemic in the year 2020

Down

2. Ability of the body to resist infections
3. Substance that makes the outer part of the virus
4. A method to get rid of germs / microbes
5. The genetic material of an organism

CHAPTER 2

SITA LEARNS ABOUT THE MICROBES FROM HER TEACHER

Two weeks later, Sita, interacts with her teacher after an online class

Hello, Sita. How is your grandfather, now?

Thank you, Ma'am. He is recovering. Ma'am, Please help me to catch up with the classes I've missed



When you were absent, we learnt about microbes in class. We covered the topic of bacteria and its role in our lives.

Ma'am, could you please explain the topic to me?



Of Course. Have a look at these slides

Sure ma'am

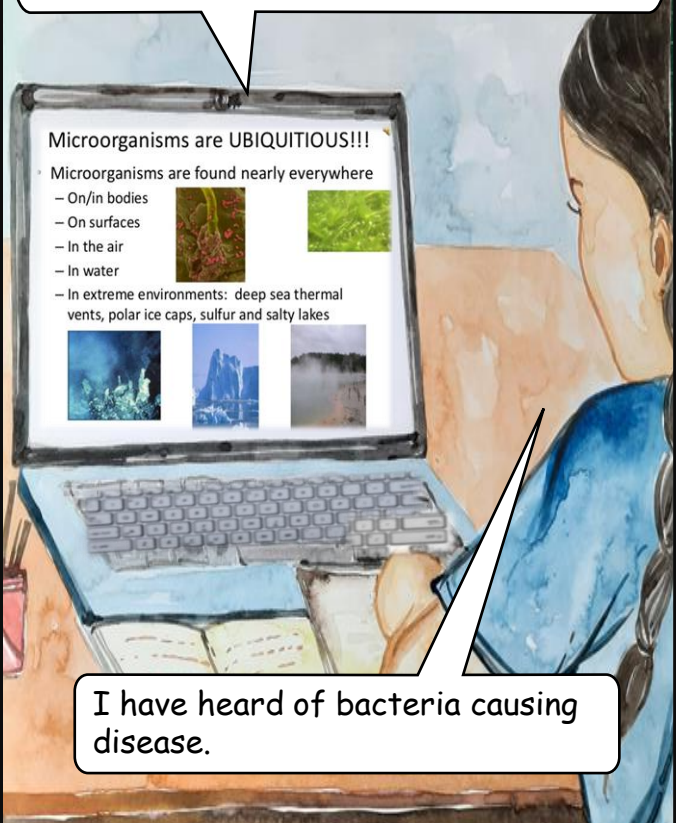


Microbes, as the name suggests can only be seen with the help of a microscope. The harmful microbes are called germs.



Germs! They are shown in the advertisement of soaps, sanitizers and toothpaste.

Microbes are found everywhere - in water, in soil, on plants and animals, even inside our bodies, some bacteria cause cavities in tooth.

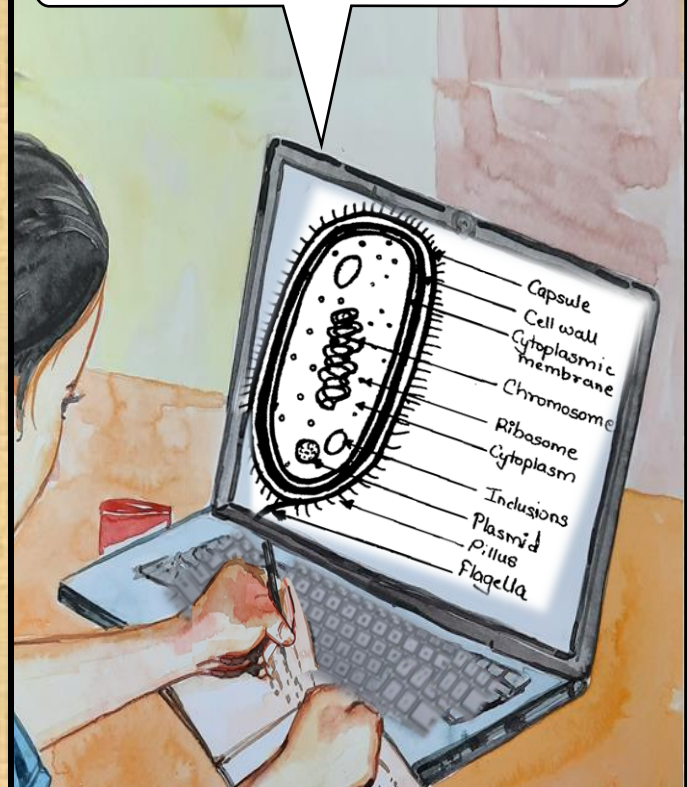


I have heard of bacteria causing disease.

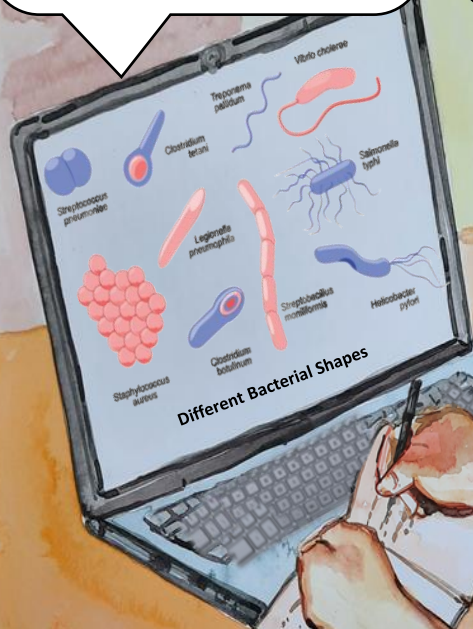
There are different types of microbes - bacteria, fungi, protozoa and algae, besides viruses.



This figure shows the structure of bacterial cell.

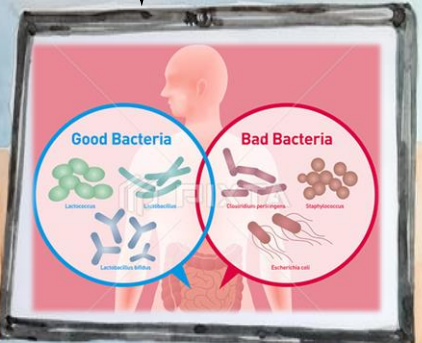


Yes, diseases like typhoid, cholera, tuberculosis, etc. are caused by bacteria. The microbes that cause diseases are called pathogens.



At this juncture, I want to tell you that some of the microbes are good too.

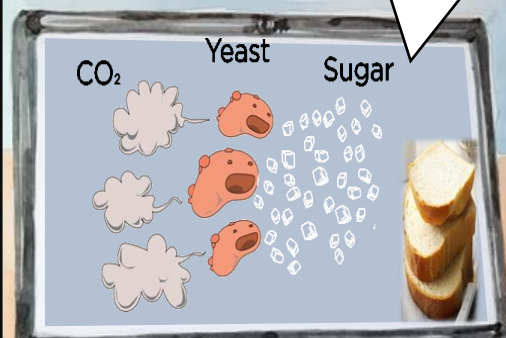
Oh! Really.



Yes, Lactobacillus is one of the useful bacteria, it helps in the formation of curd. There are other bacteria which help in making Idli - Dosa, Dhokla, Bhature, etc.



And yeast, another microbe (fungi) helps to make bread. It produces carbon dioxide (CO_2) when mixed with dough. On baking, CO_2 escapes from the dough making it spongy.



It also helps in making wine and beer.

Some microbes like Rizobium, Anabena, etc. enrich the soil by converting atmospheric nitrogen to nitrogen compounds in the soil, which are used by plants to grow. This is also known as Nitrogen fixation.



ORGANIC MATTER

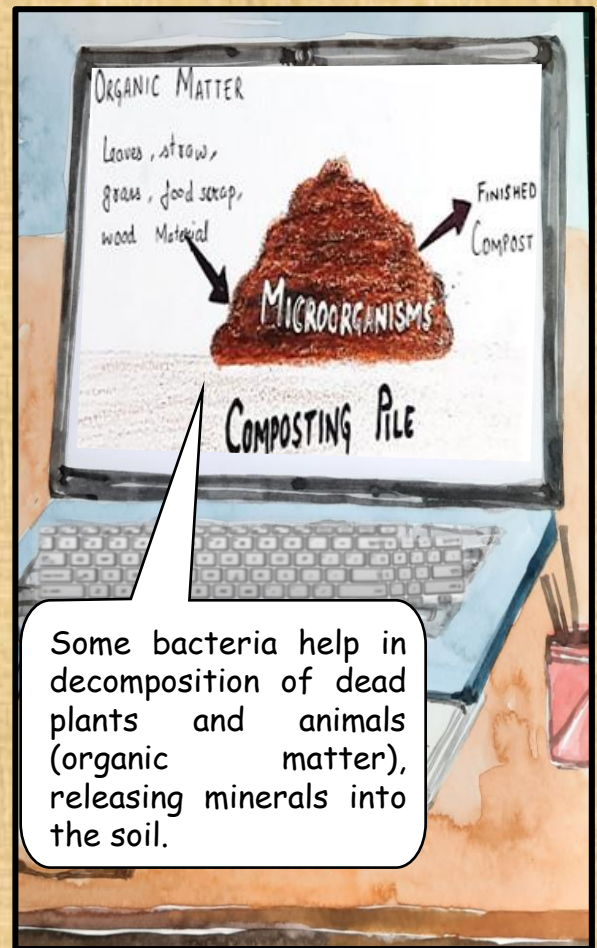
Leaves, straw,
grasses, food scrap,
wood Material

FINISHED
COMPOST

MICROORGANISMS

COMPOSTING PILE

Some bacteria help in decomposition of dead plants and animals (organic matter), releasing minerals into the soil.



This was the lesson we covered when you were away. I will share the PPT with you to revise.

I want to learn more about viruses. Could you please, suggest a book that could help me?



Sure, Sita. There is an excellent book I can recommend. Let me send you the details. You can order it online.

Thank you, Ma'am.

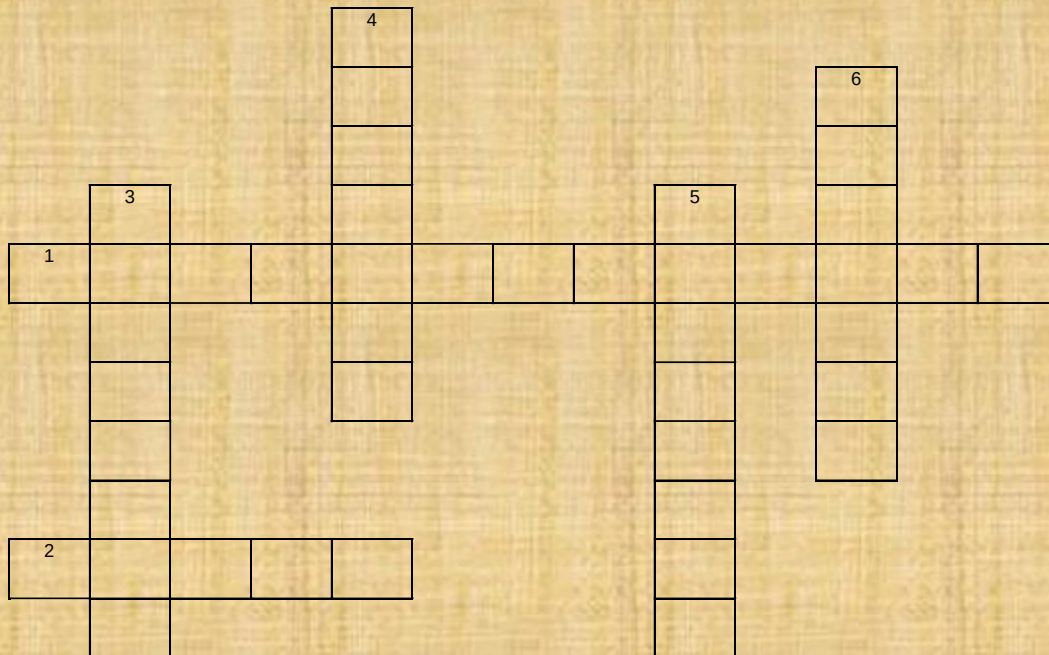


Check your understanding

Choose the correct option

1. Microbes are found
 - A. In / On Plants
 - B. In /on animal body
 - C. In pond
 - D. All of the above
2. Different types of microbes are
 - A. Bacteria and Viruses
 - B. Protozoa
 - C. Algae
 - D. All of the above
3. Number of cell(s) in bacteria is / are
 - A. One
 - B. Many
 - C. Variable
 - D. None of the above

Solve the crossword puzzle



Across

1. The bacteria that helps in formation of curd
2. The microbe that is used for making bread

Down

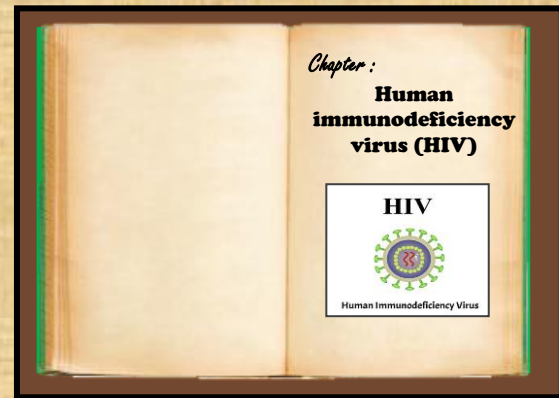
3. Disease causing organism
4. This is formed by decomposition of plant and animal waste
5. This element is present in air and fixed in soil by microbes
6. A disease caused by bacteria

1. LACTOBACILLUS 2. YEAST 3. PATHOGEN 4. COMPOST 5. NITROGEN 6. CHOLERA

CHAPTER 3

SITA LEARNS ABOUT THE EVIL NATURE OF VIRUSES

One week later



HIV attacks the white blood cells (soldiers of the body) and weakens the immune system of the body. Over a period of time, the infected individuals become susceptible to a variety of infections that healthy people can resist.

A normal person recovers from common cold in few days but HIV infected individual is unable to recover.

HIV infection, if not treated results in **Acquired Immunodeficiency Syndrome (AIDS)**.

What are the symptoms of HIV?

Many people who are infected with HIV do not show any symptoms until many years after infection. The following may be warning signs of advanced stage of HIV infection:

- Rapid weight loss, dry cough, recurring fever, or severe night sweats
- Profound and unexplained

fatigue, swollen lymph glands in the armpits, groin, or neck

- Diarrhoea that lasts for more than a week
- White spots or unusual marks on the tongue, the mouth, or the throat
- Memory loss, depression, and other neurological problems

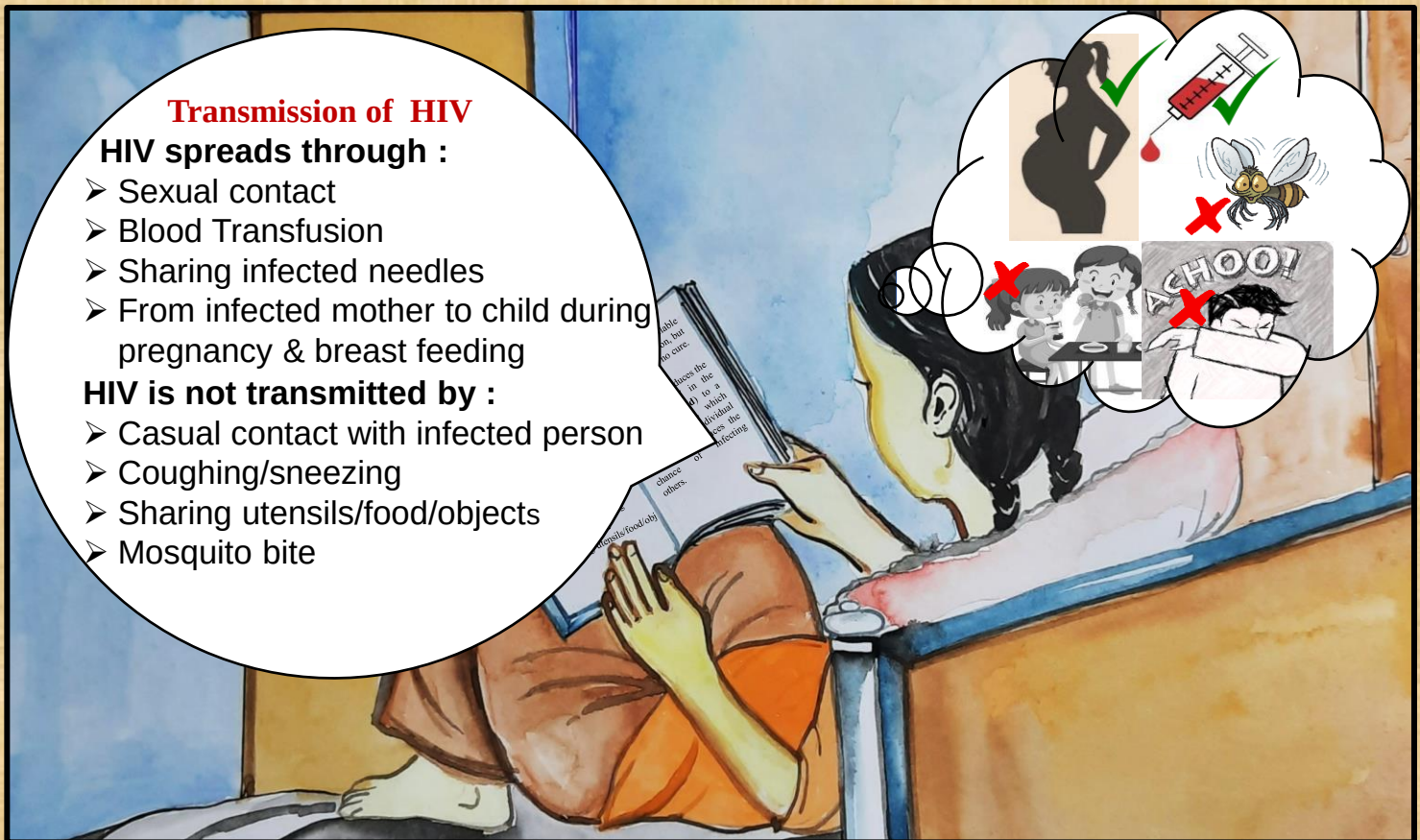
Transmission of HIV

HIV spreads through :

- Sexual contact
- Blood Transfusion
- Sharing infected needles
- From infected mother to child during pregnancy & breast feeding

HIV is not transmitted by :

- Casual contact with infected person
- Coughing/sneezing
- Sharing utensils/food/objects
- Mosquito bite



Can HIV be treated or cured?

Medicines are available to treat HIV infection, but there is currently no cure.

HIV medicine reduces the amount of HIV in the body (**viral load**) to a very low level, which keeps the individual healthy and reduces the chance of infecting others.

The following measures will help in **prevention of AIDS**

- Opting for safe sex
- Avoid sharing of needles / use disposable needles.
- Testing blood for AIDS before transfusion

When Dadaji was diagnosed with Covid-19 we were told to maintain social distance but in case of AIDS social distancing is not required. It is so because the two viruses spread through different ways.



Sita, come to the drawing room. Fogging is to be done in your room.



Yes, Mummy. I will be there in two minutes.





Check your understanding



Help Sita to give a star to the true statements and correct the false ones.

1. HIV attacks red blood cells.

2. Drug addicts get infected by HIV due to sharing of drugs.

3. HIV is transmitted by mosquito bite.

4. Disposable needles should be used for tattooing

5. Blood should be tested for HIV before transfusion.

6. Infected mother can transmit HIV to the child during pregnancy.

7. Infected mothers can breastfeed their infants.

8. Medicines can cure HIV infection.

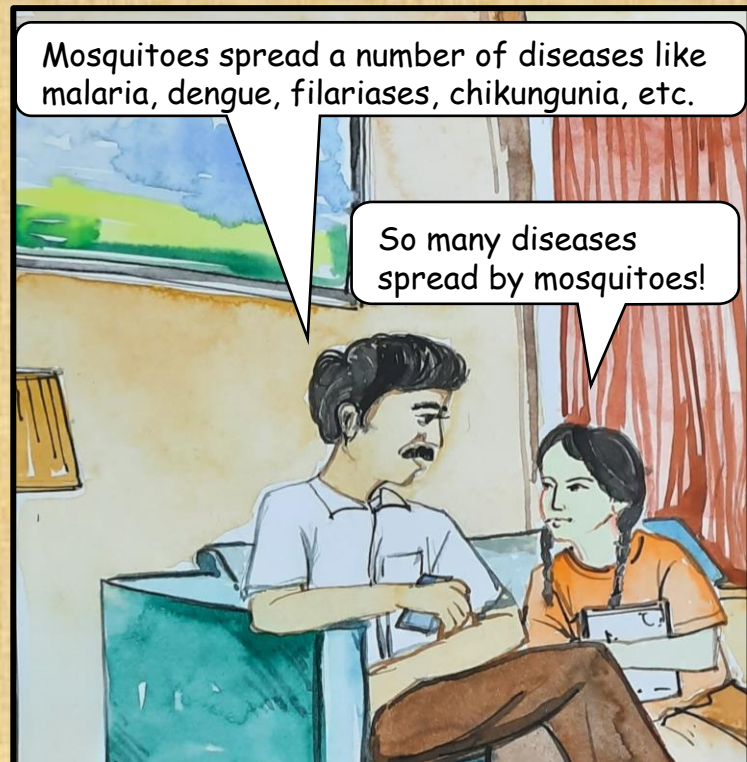
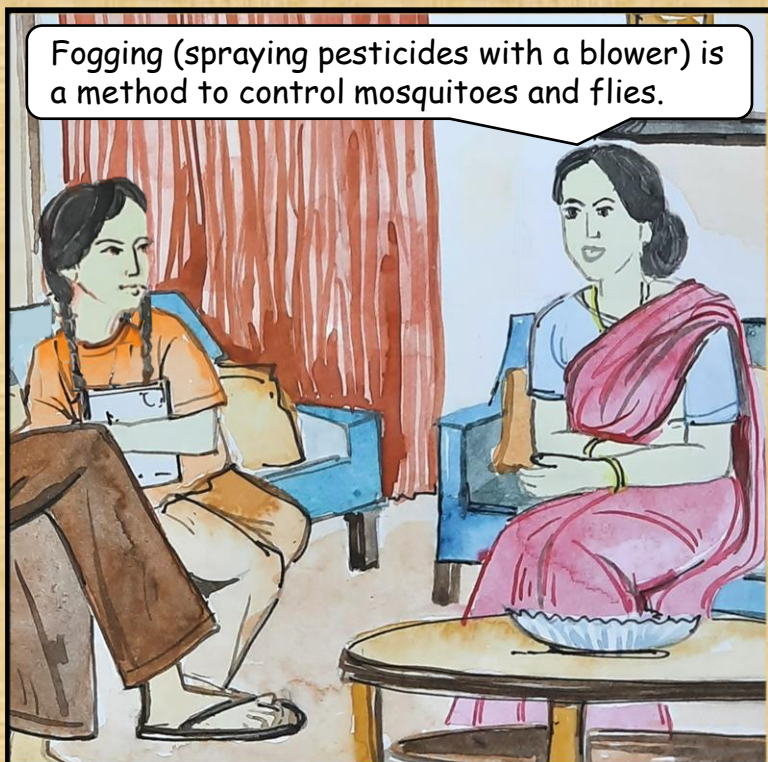
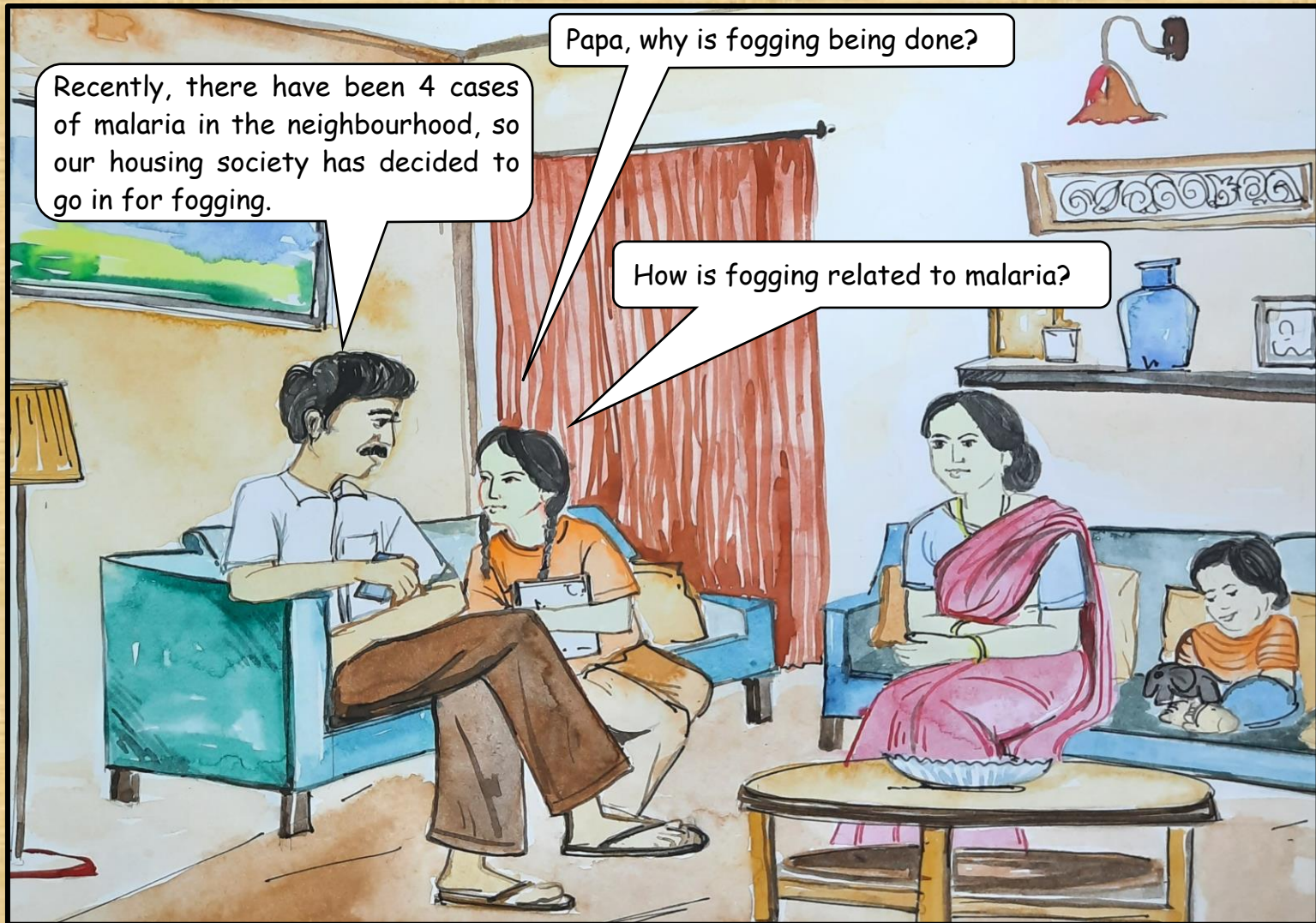
9. Social distance should be maintained with HIV infected individuals.

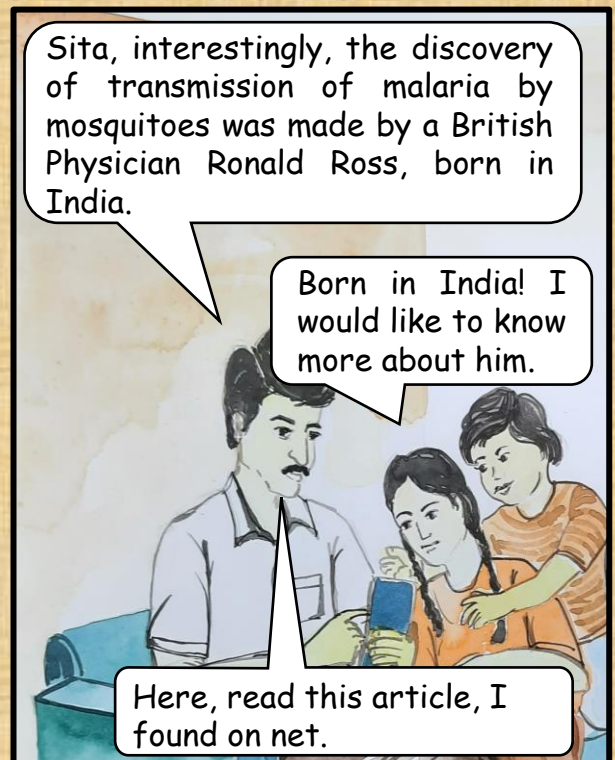
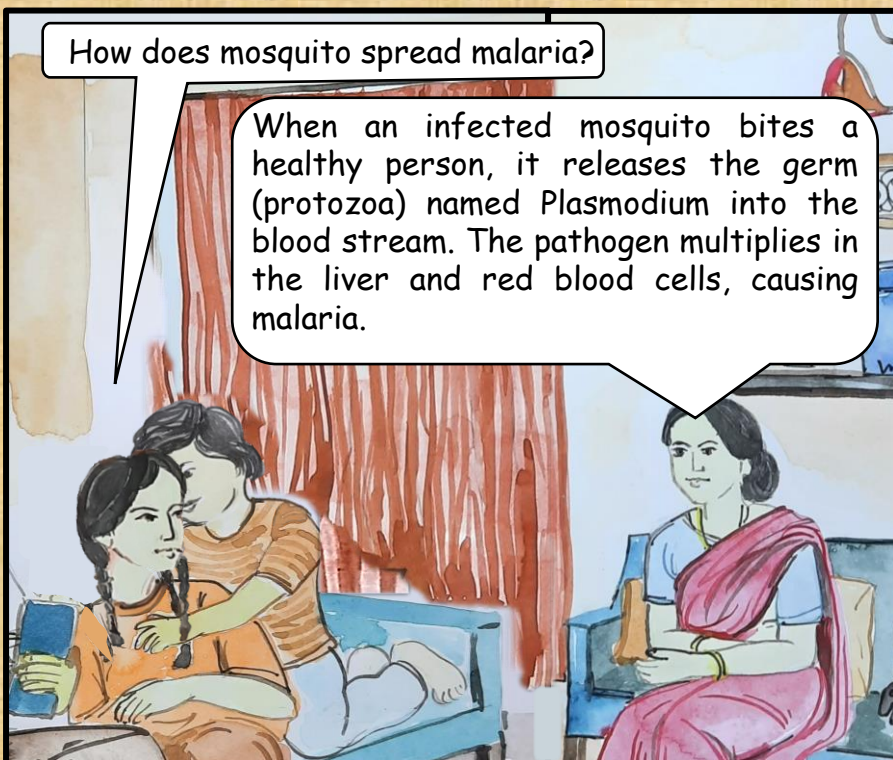
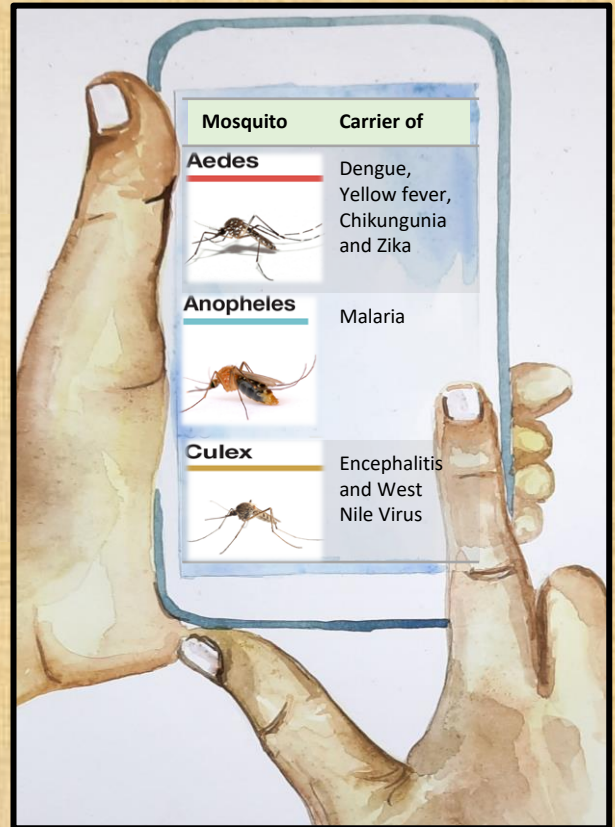
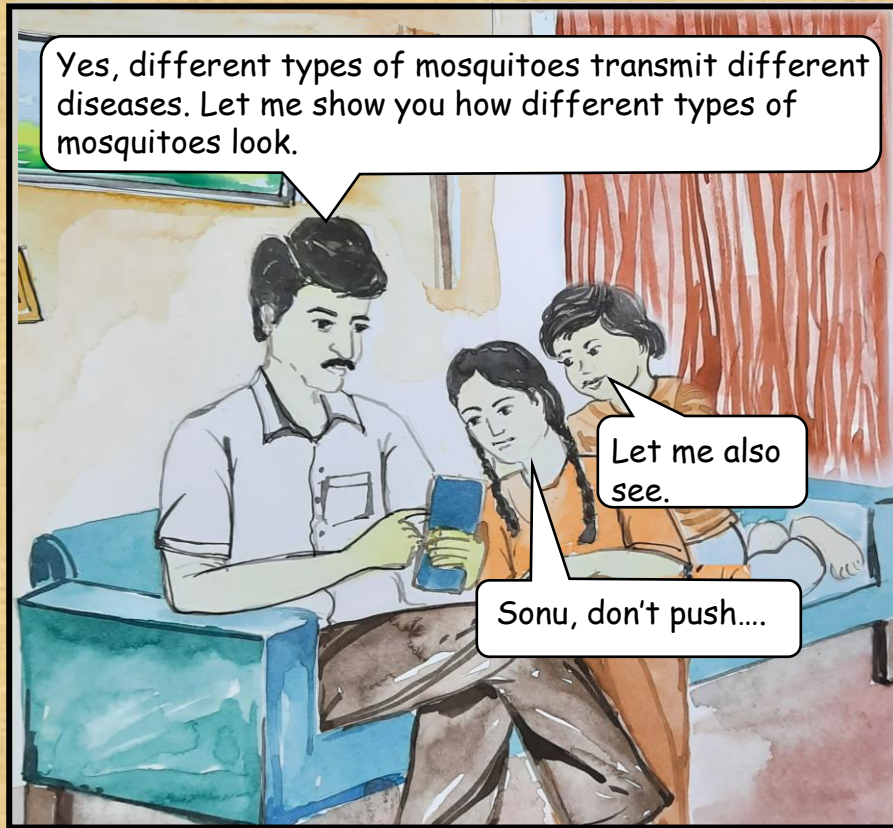
10. HIV infected individuals are unable to fight infections which healthy people are able to overcome.

True/Star - 5, 6, 10 False - 1, 2, 3, 4, 7, 8, 9

CHAPTER 4

SITA LEARNS ABOUT MALARIA







Ronald Ross was born in Almora, India in 1857 to Sir C.C.G. Ross, a General in the Indian Army, and Matilda C. Elderton. He studied medicine from Barts and The London School of Medicine and Dentistry.

He worked in the Indian Medical Service for 25 years. It was during this time that many people suffered from malaria, especially in the areas with lot of rainfall and swampy places. It was thought that the foul air caused the disease and therefore it was named malaria, meaning "bad air". But there was no proof.

Many scientists were engaged in research on malaria. A doctor reported presence of tiny germs in the blood of an infected person, but the source was not clear. Ross was guided by his professor to explore the possibility of mosquitoes being the carriers of malaria. He started catching, dissecting and observing the inside of mosquitoes' stomach. He spent several hours bent over the microscope. One day, he caught an unusual brownish mosquito with spotted wings. While observing the stomach of this female Anopheles mosquito, he saw the tiny germs similar to those seen in the blood of a malaria patient. This was a breakthrough and subsequent experiments conclusively proved malaria was spread by mosquitoes.

He was awarded the Nobel Prize for medicine for his contribution in 1902.



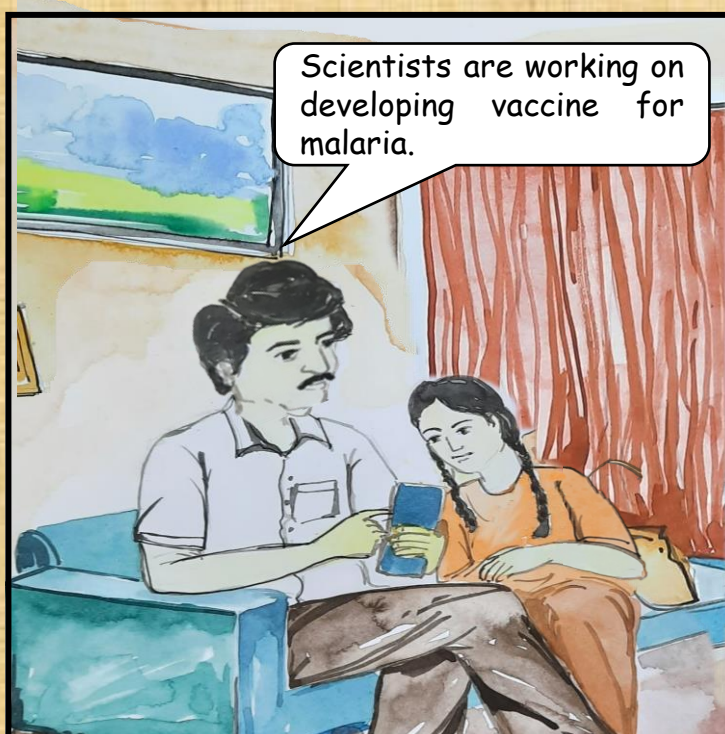
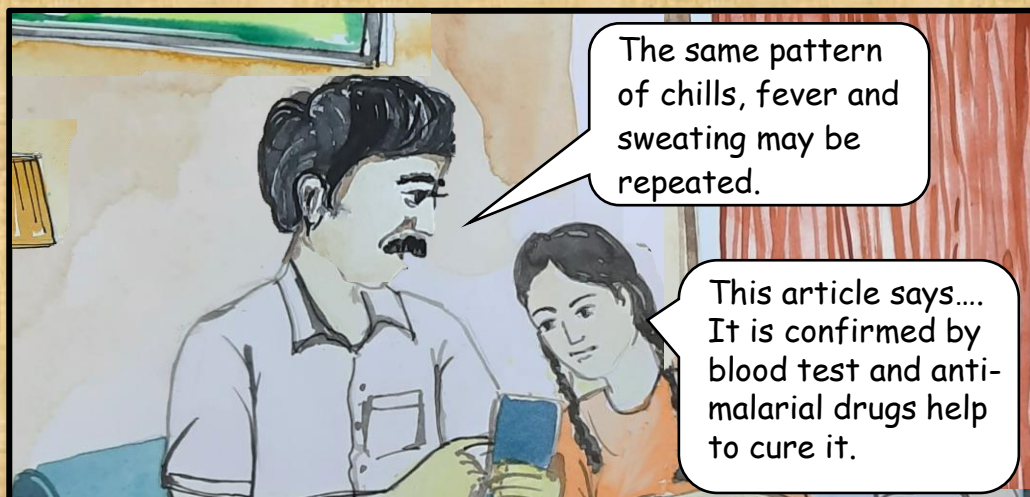
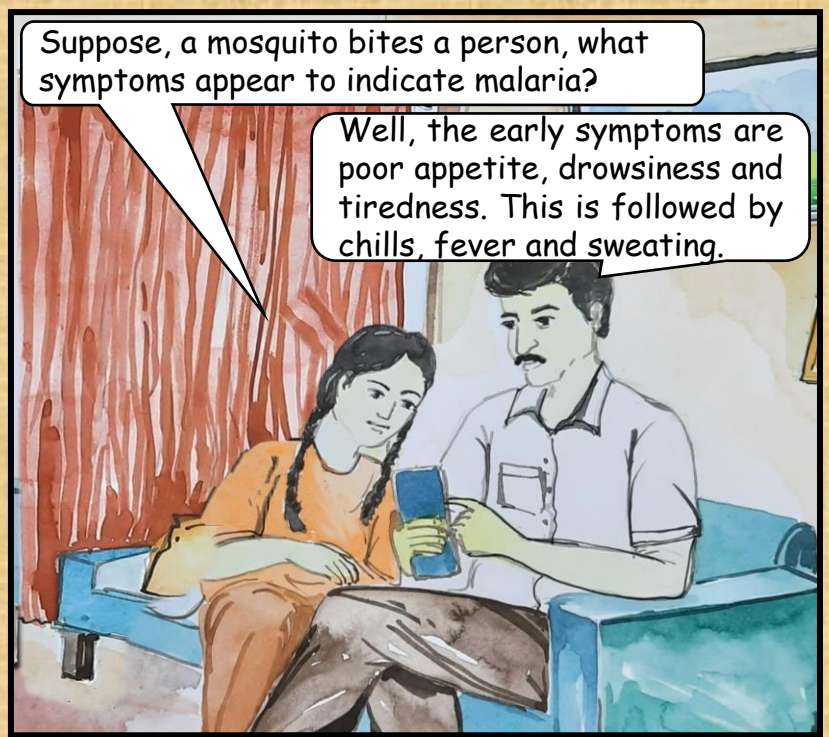
Thanks to him, for this path breaking discovery. It saved many lives.

This is amazing ! I also wish to do something like this. I will become a scientist.



So, controlling mosquitoes reduces the chances of people suffering from malaria.

Yes, use of mosquito nets and mosquito repellents are also effective methods.



Check your understanding

1. What is fogging?
2. Which of the following words can be paired together :

Anopheles

Encephalitis

Aedes

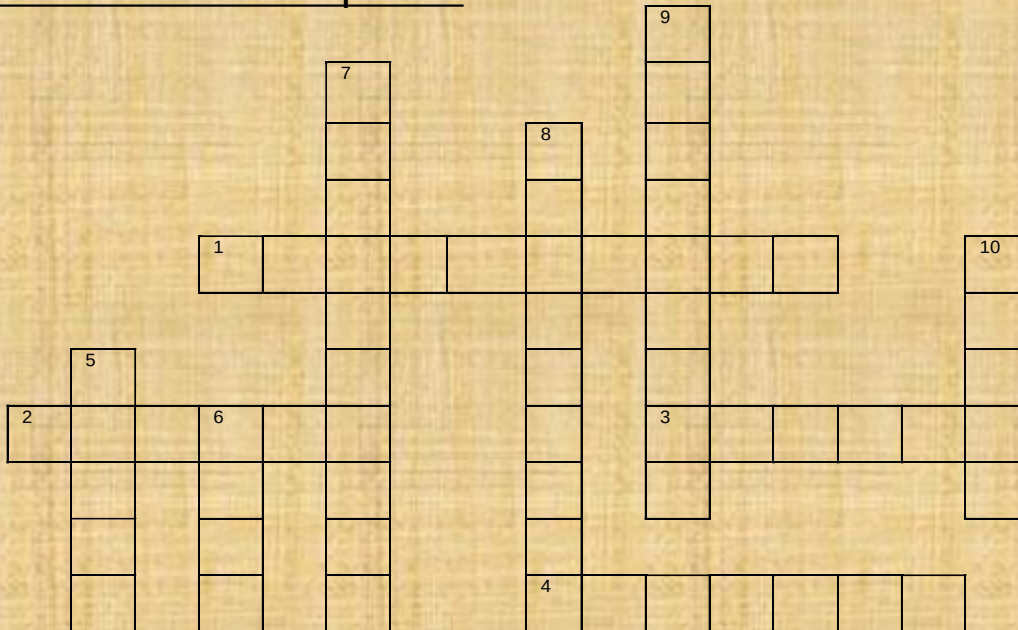
Malaria

Culex

Dengue

3. How is it malaria confirmed?
4. What are the symptoms of malaria?
5. What measures should be taken to prevent malaria?

Solve the crossword puzzle



Across

1. The protozoa that causes malaria
2. The meaning of malaria
3. The disease spread by Aedes mosquito
4. The part of the mosquito body where Ronald Ross observed the malarial pathogen

Down

5. Mosquitoes lay eggs in this
6. The species of mosquito that spreads Chikungunia
7. The doctor who got the Nobel prize for his work on malaria
8. The species of mosquito that spreads malaria
9. The chemical used for killing pests
10. The species of mosquito that spreads filariasis

1. PLASMODIUM 2. BAD AIR 3. DENGUE 4. STOMACH 5. WATER 6. AEDES 7. RONALD ROSS 8. ANOPHELES 9. PESTICIDE 10. CULEX

CHAPTER 5

SITA LEARNS ABOUT VACCINES – A JOURNEY INTO THE PAST



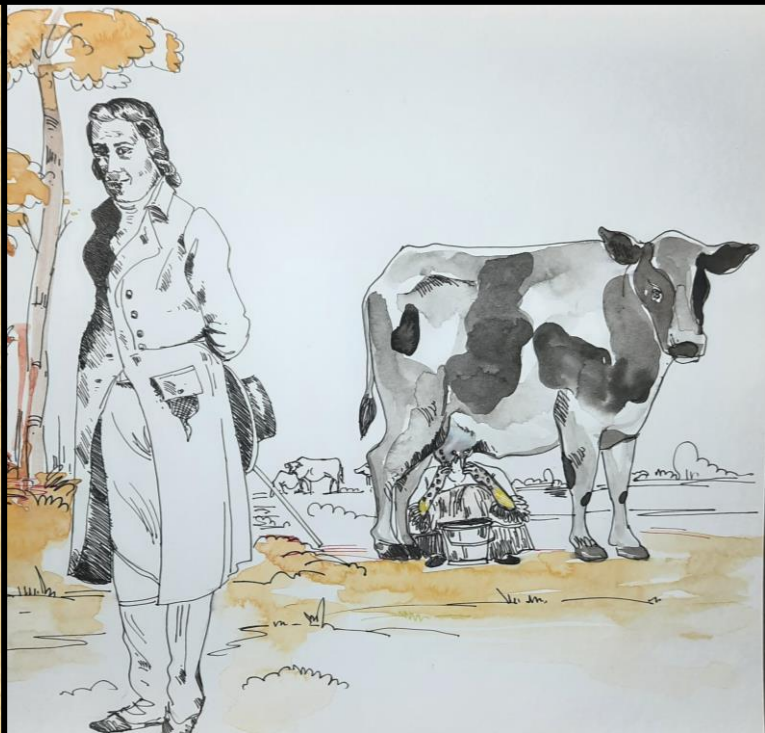
Small pox was the leading cause of death in 18th Century. Many people died and those who survived had scars on their body. The deadly disease was caused by Variola virus.



Edward Jenner, a British Physician settled in the countryside in Berkley, noticed that the milkmaids who suffered from cowpox did not develop small pox.

These milkmaids got cowpox infection while milking infected cows; the symptoms were very similar to small pox but milder in nature.

He pondered over this observation and one day when a milkmaid Sarah Nelmes suffering from cowpox came to him, he did a bold experiment.



He took the sample of pus from her cowpox blisters and introduced it into a small boy named James Phipps, his gardener's son. James suffered from cowpox and recovered. Jenner then infected James with pus taken from a small pox patient. James did not suffer from small pox.



He repeated this with some other children, including his son and found it to be an effective way to prevent small pox.

Jenner named this inoculation process, "vaccination", from the Latin name for cow (vacca) and cowpox (vaccinia).

Many lives were saved using this technique.



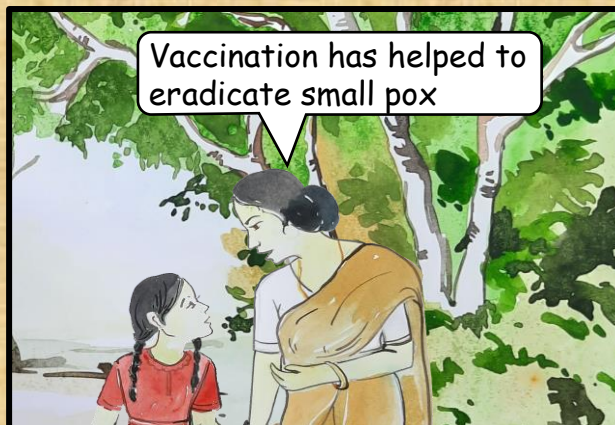
The principle of vaccination is that the immune cells (WBCs) remember the pathogen (disease causing agent) after the first encounter. Next time, when the pathogen enters the body, the WBCs recognize it and swing into action.



The first exposure of pathogen to WBC is like showing a picture of the culprit to the police. Next time, when the pathogen enters the body, police easily catches the culprit and the person is safe.



Vaccination has helped to eradicate small pox



For vaccination, the pathogen is weakened or killed and then injected into a person for immunization (to prepare the immune system to inactivate the pathogen).



There is a vaccination schedule to be followed for new born children, to build their immunity for a number of diseases. I will show you the vaccination schedule, we are following for Sonu.

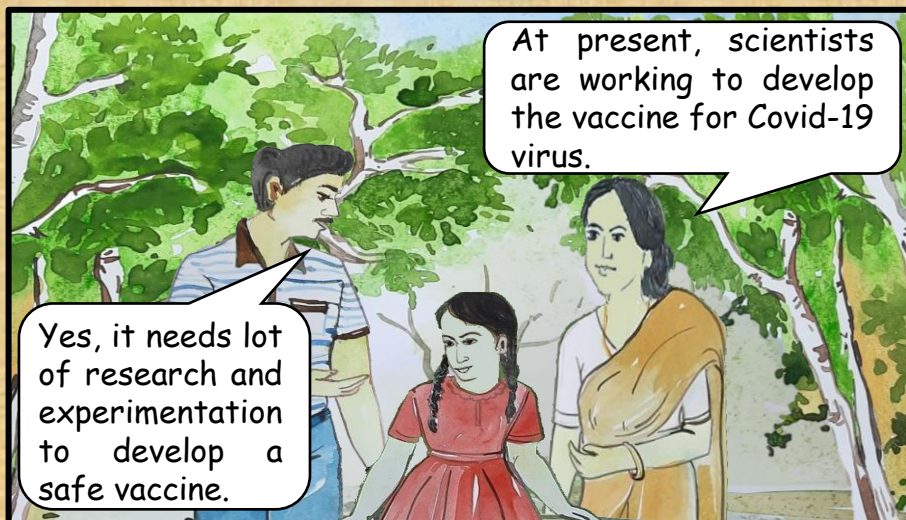


VACCINATION CHART

S.No	Vaccine	Prevents	Minimum Age for Dose 1	Interval Between Dose 1 & Dose 2	Interval Between Dose 2 & Dose 3	Interval Between Dose 3 & Dose 4	Interval Between Dose 4 & Dose 5
1	BCG	TB & bladder cancer	Birth				
2	HepB	Hepatitis B	Birth	4 weeks	8 weeks		
3	Poliovirus	Polio	Birth	4 weeks	4 weeks		
4	DTP	Diphtheria, Tetanus & Pertussis	6 weeks	4 weeks	4 weeks	6 months (Booster 1)	3 years (Booster 2)
5	Hib	Infections caused by Bacteria	6 weeks	4 weeks	4 weeks	6 months (Booster 1)	
6	PCV	Pneumonia	6 weeks	4 weeks	4 weeks	6 months (Booster 1)	
7	RV	Severe Diarrheal Disease	6 weeks	4 weeks	4 weeks		
8	Typhoid	Typhoid Fever, Diarrhea	9 weeks	15 months (Booster 1)			
9	MMR	Measles, Mumps & Rubella	9 weeks	6 months			
10	Varicella	Chickenpox	1 year	3 months			
11	HepA	Liver disease	1 year	6 months			
12	Tdap	Diphtheria, Tetanus & Pertussis	7 years				
13	HPV	Some Cancers & Warts	9 years	For Child aged 9-14 years: 6 months For Child aged 15 or more: 1 month	For Child aged 15 or more: 5 months		

At present, scientists are working to develop the vaccine for Covid-19 virus.

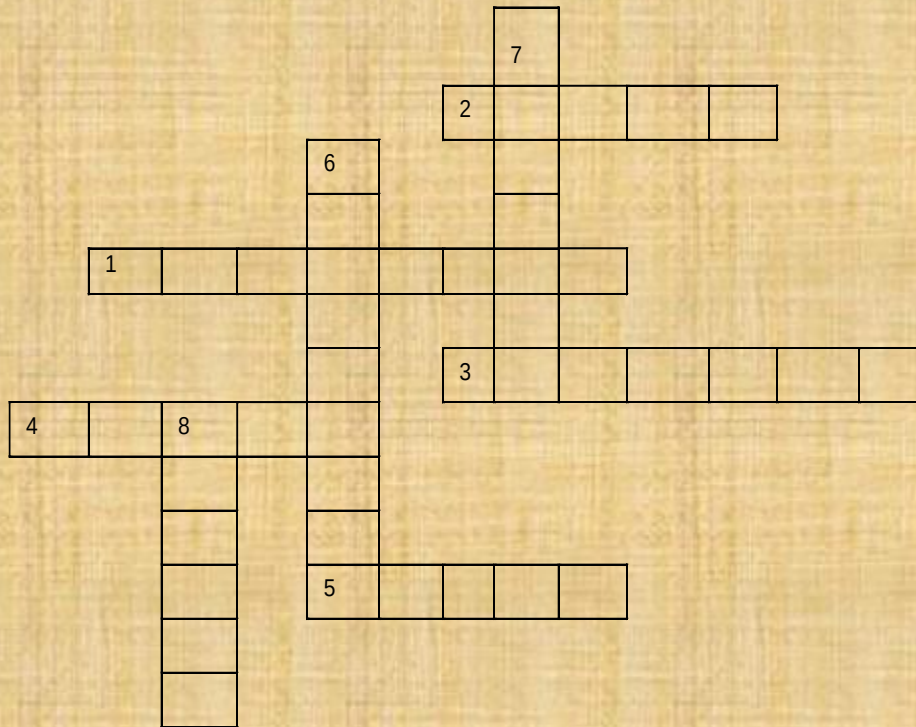
Yes, it needs lot of research and experimentation to develop a safe vaccine.



Check your understanding

1. What is the principle of vaccination?
2. Name two vaccines given to a child in the first year.

Solve the crossword puzzle



Across

1. A viral disease that leaves scars on the skin of the survivors
2. Name of the boy who got first vaccine
3. The preparation that is administered to provide immunity
4. Latin word for cow
5. Name of the milkmaid who suffered from cowpox and the pus from her blisters was taken for experiment by Jenner

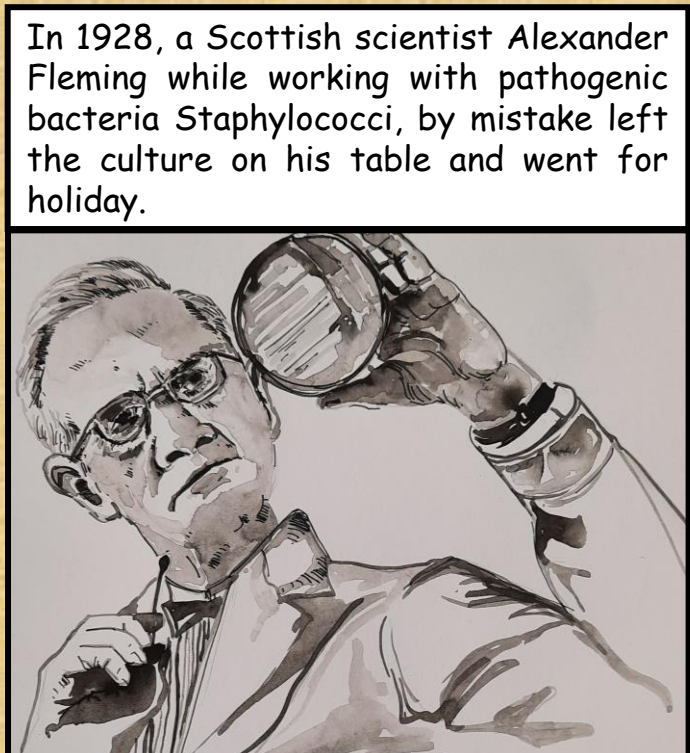
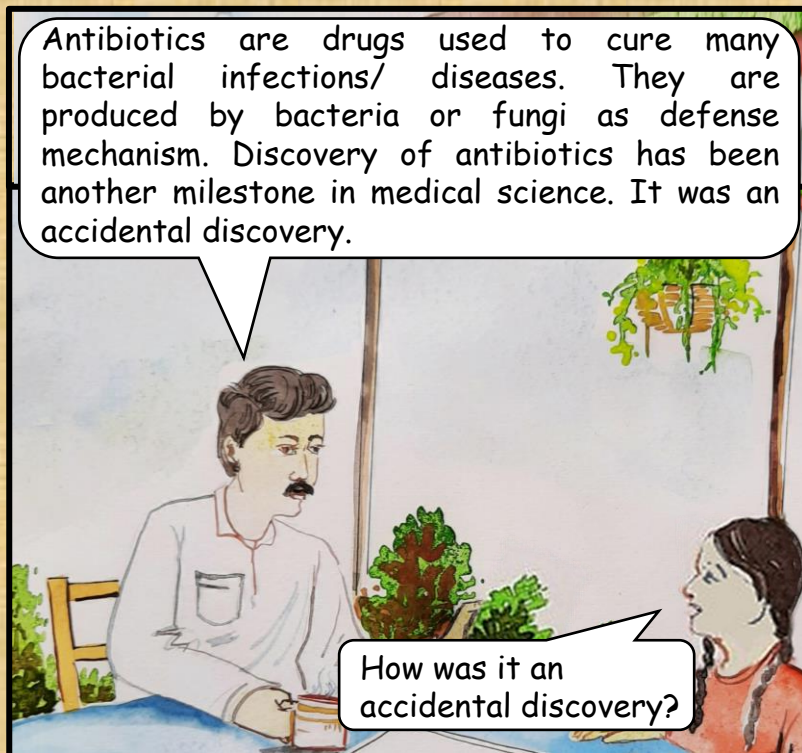
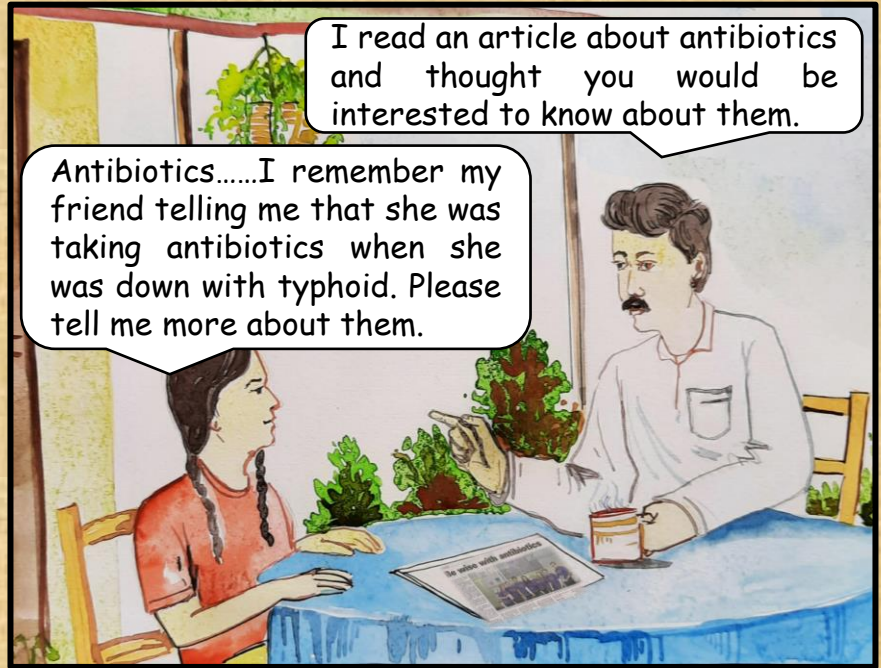
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6. Female who works in a dairy and milks cattle
7. Name of the virus that causes smallpox
8. A mild form of smallpox affecting cow

1. SMALLPOX 2. JAMES 3. VACCINE 4. VACCA 5. SARAH 6. MILKMAID 7. VARIOLA 8. COWPOX

CHAPTER 6

SITA LEARNS ABOUT ANTIBIOTICS



When he came back, he saw a mould (*Penicillium*) growing on the plate with a clear zone around it. Bacteria were not growing around it. He concluded that the mould was producing some chemical which killed the bacteria

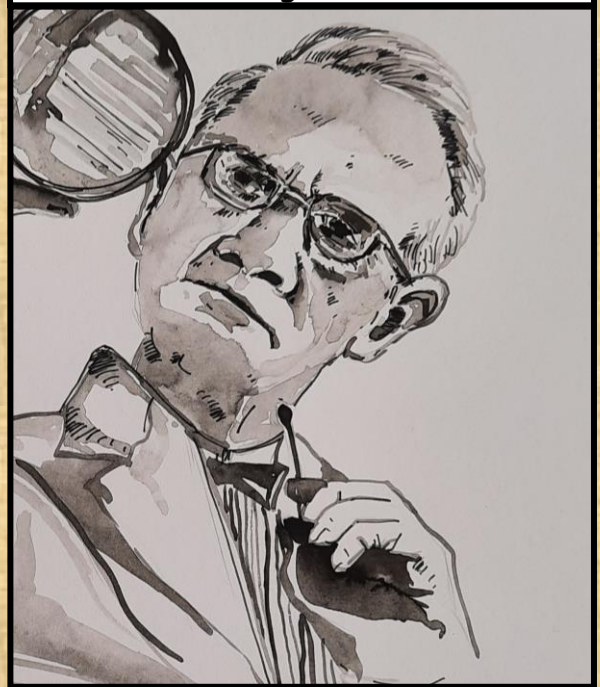


After lot of experimentation, he purified the compound with anti-bacterial properties from the mould *Penicillium* and called it Penicillin.

Penicillin was produced on a large scale and used to treat wounds of millions of soldiers during world war II.



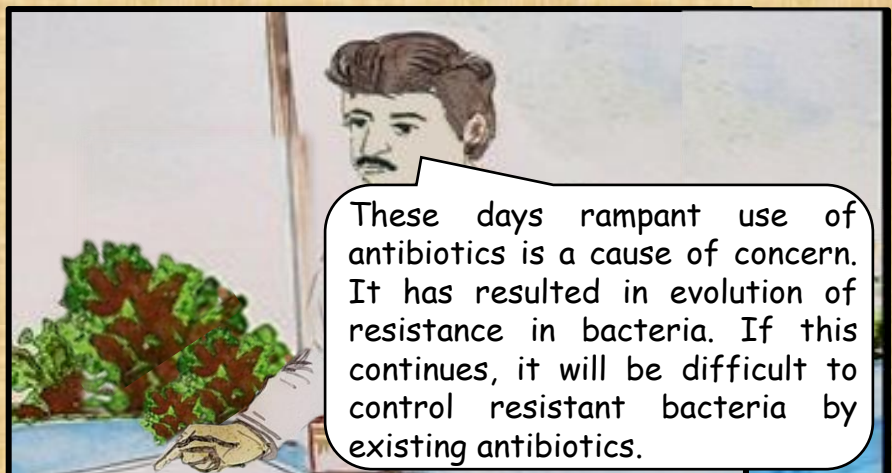
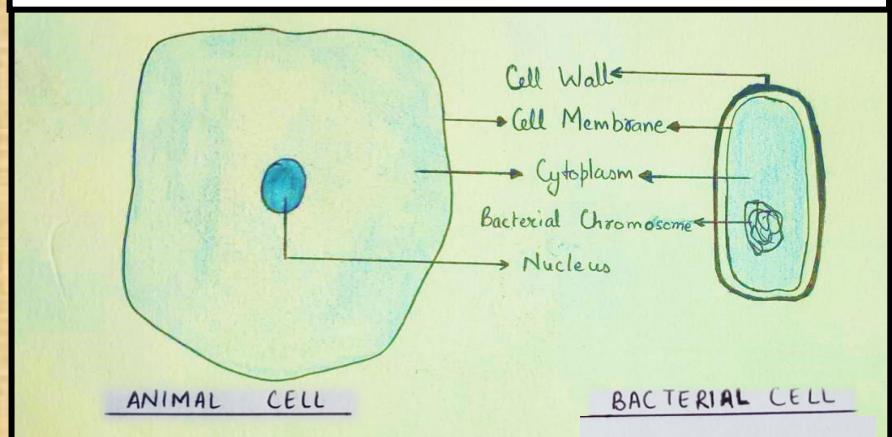
In 1945, Alexander Fleming and his co-workers received the Nobel Prize for the discovery of this miracle drug.



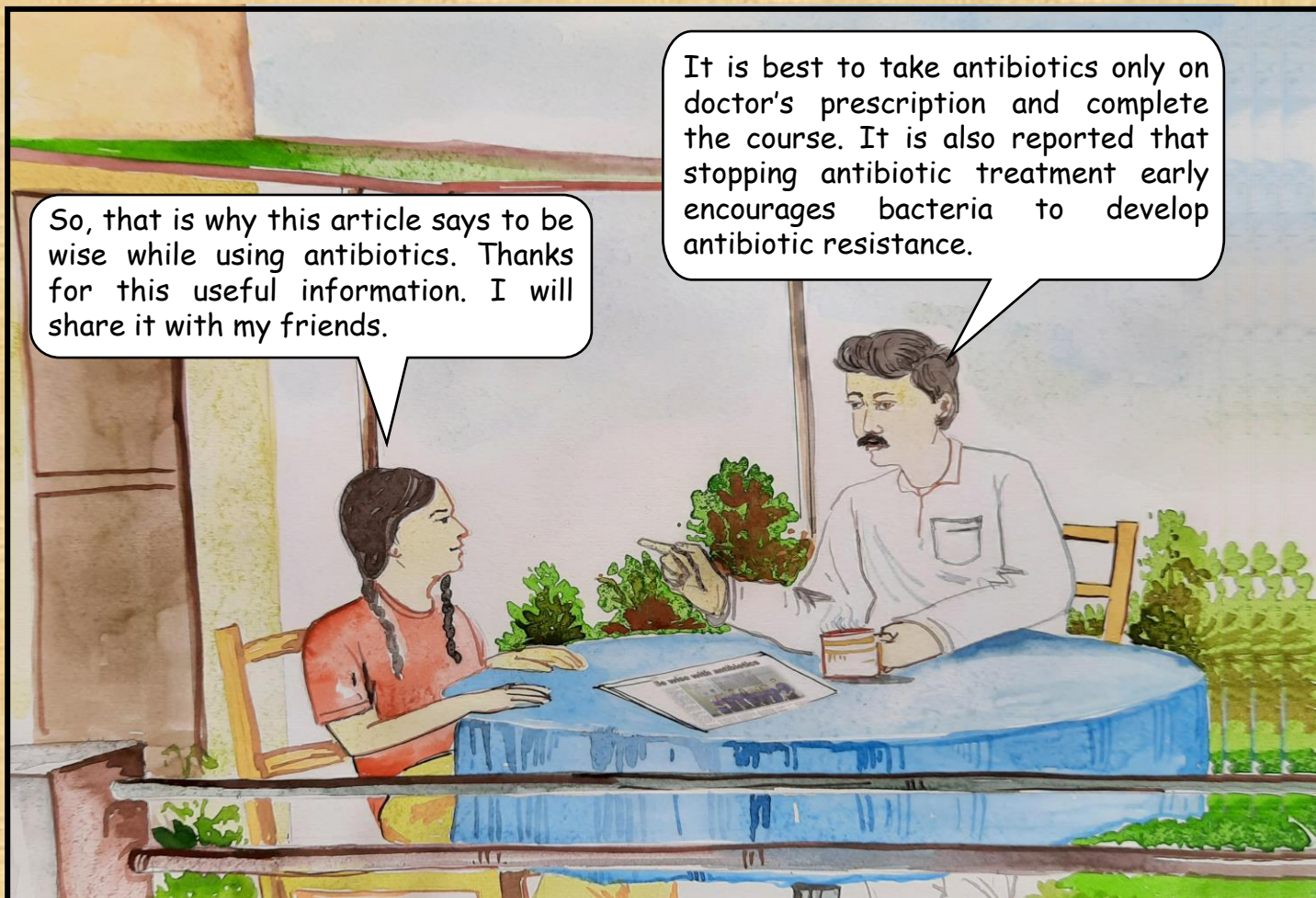
Many other antibiotics like Erythromycin, Streptomycin, etc. were discovered later on.



Research has shown that antibiotics selectively interfere with biological reactions inside bacteria and do not affect human body. For example Penicillin inhibits cell wall synthesis in bacteria and human cell do not have cell wall.



These days rampant use of antibiotics is a cause of concern. It has resulted in evolution of resistance in bacteria. If this continues, it will be difficult to control resistant bacteria by existing antibiotics.

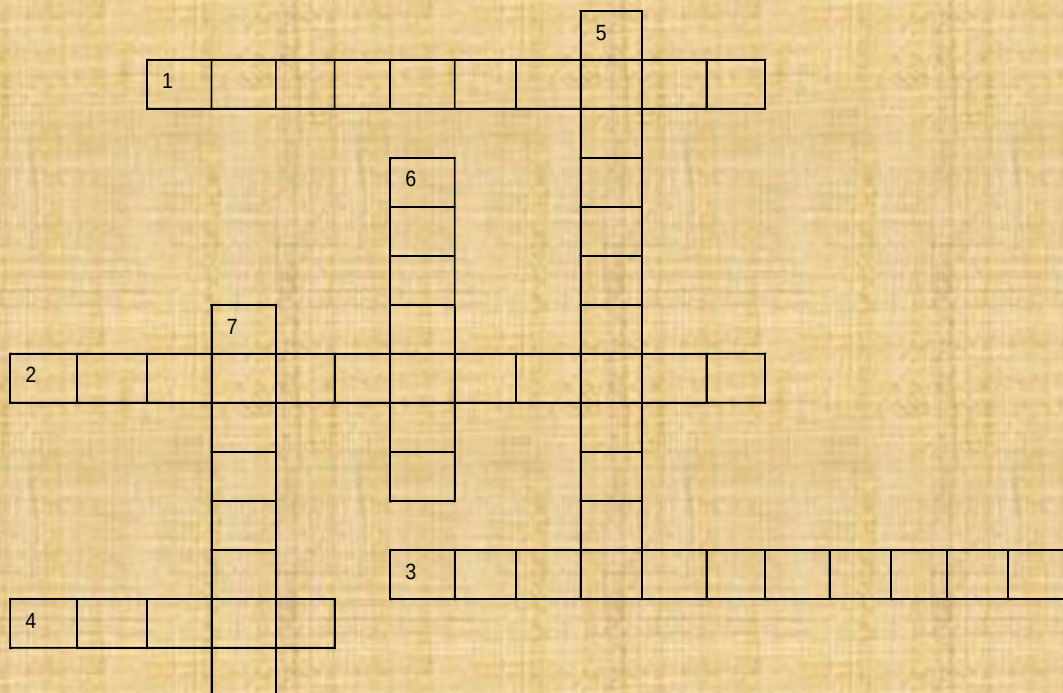


Check your understanding

Answer the following questions.

1. Penicillin is an antibacterial compound produced by _____. (virus / mould)
2. Excess use of antibiotics is good. What do you think, it's true or false?
3. Find out the names of scientists who shared the Nobel prize for penicillin with Alexander Fleming.
4. How does penicillin kill bacteria?

Solve the crossword puzzle



Across

1. Antibacterial drugs isolated from microbes
2. Antibiotic other than penicillin
3. The mould which Alexander Fleming accidentally found growing in the bacterial culture
4. Another name for fungus

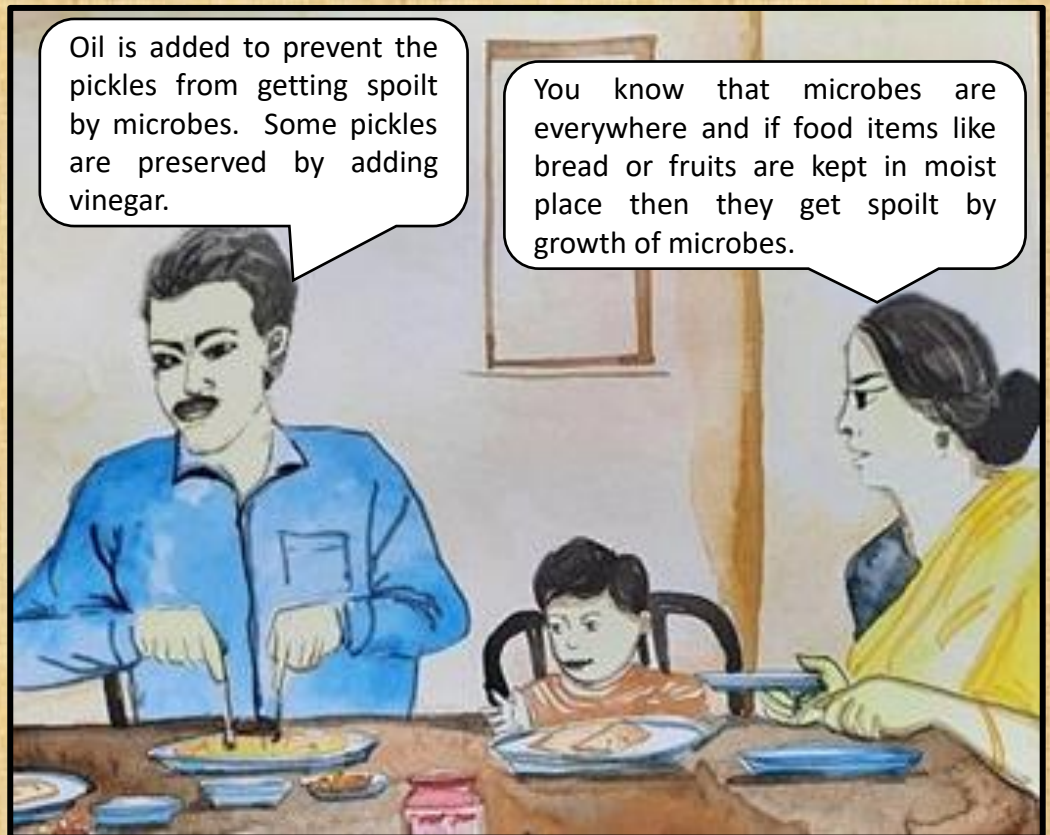
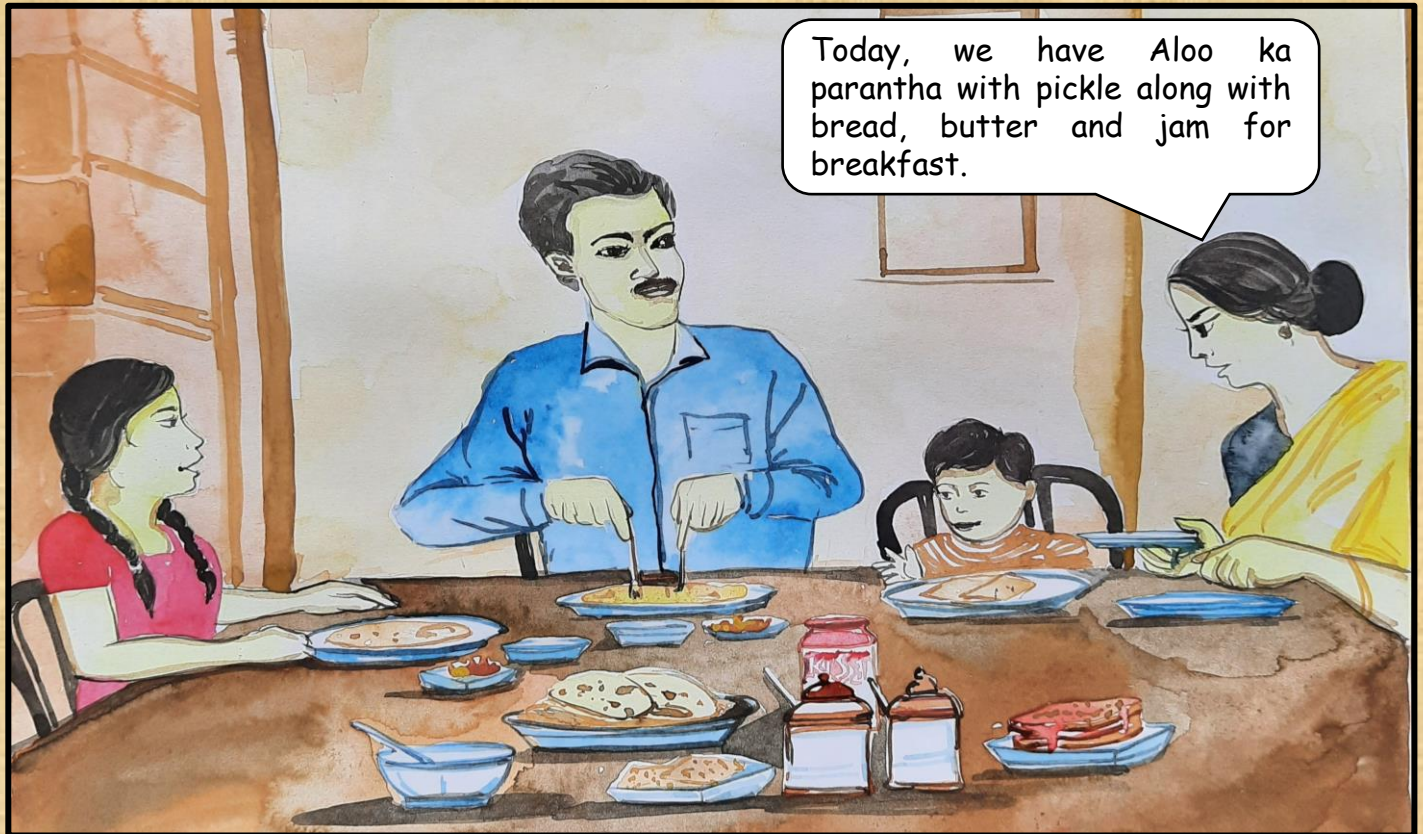
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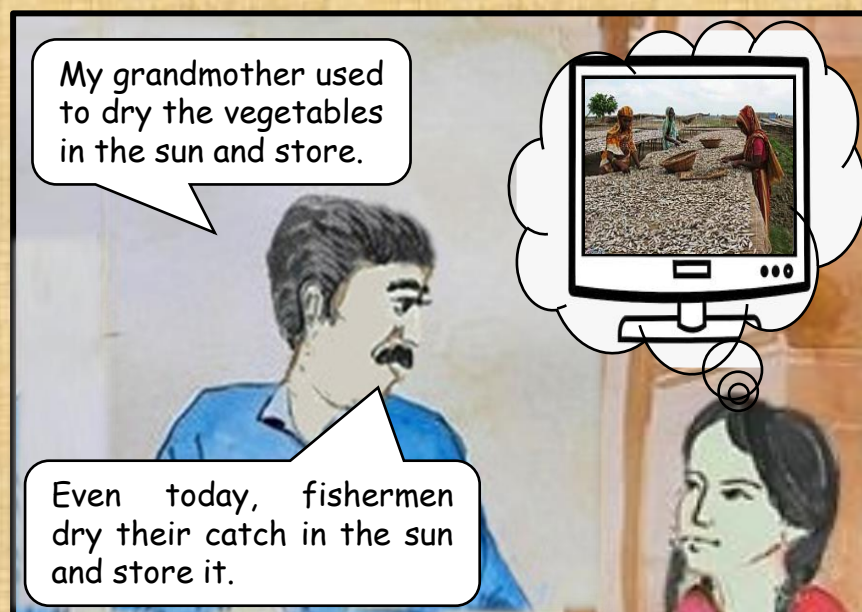
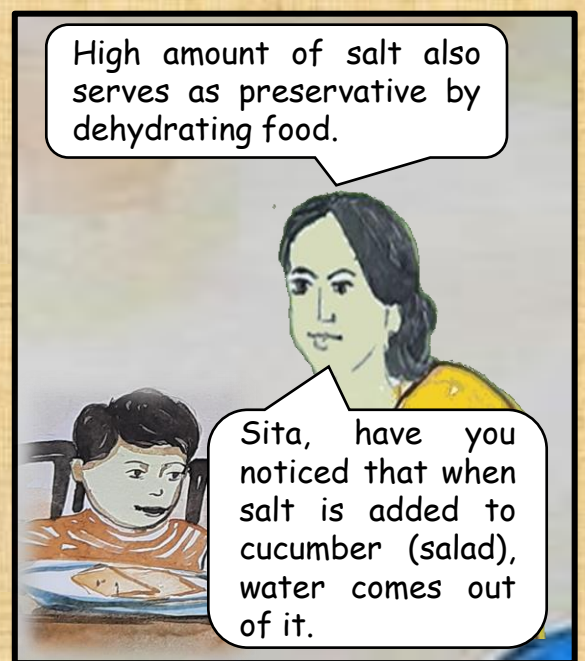
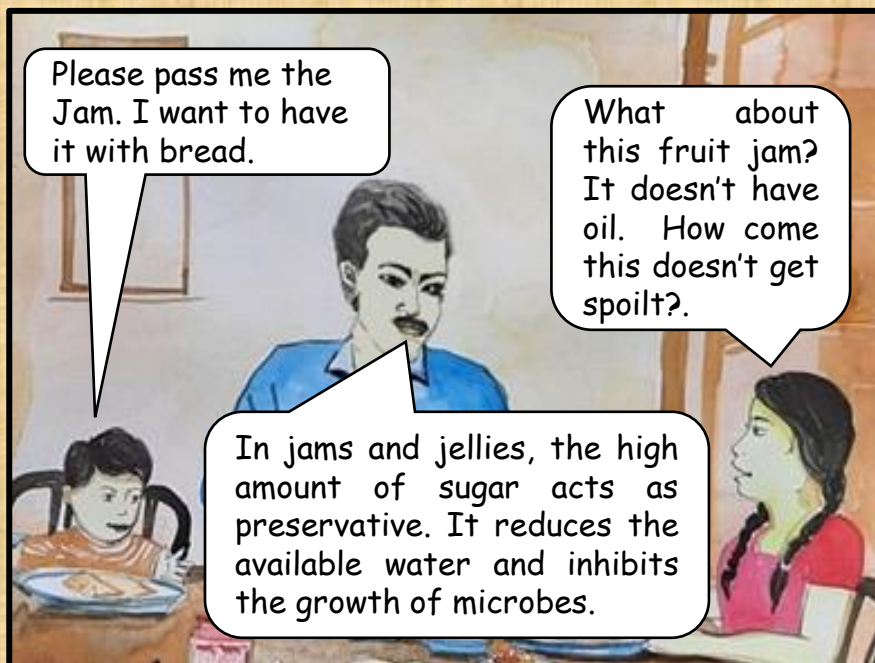
5. Alexander Fleming was working with this microorganism
6. A disease caused by bacteria, cured by using antibiotics
7. Penicillin interferes with the formation of this part of the bacterial cell

1. ANTIBIOTIC 2. STREPTOMYCIN 3. PENICILLIUM 4. MOULD 5. STAPHYLOCOCCI 6. TYPHOI 7. CELL WALL

CHAPTER 7

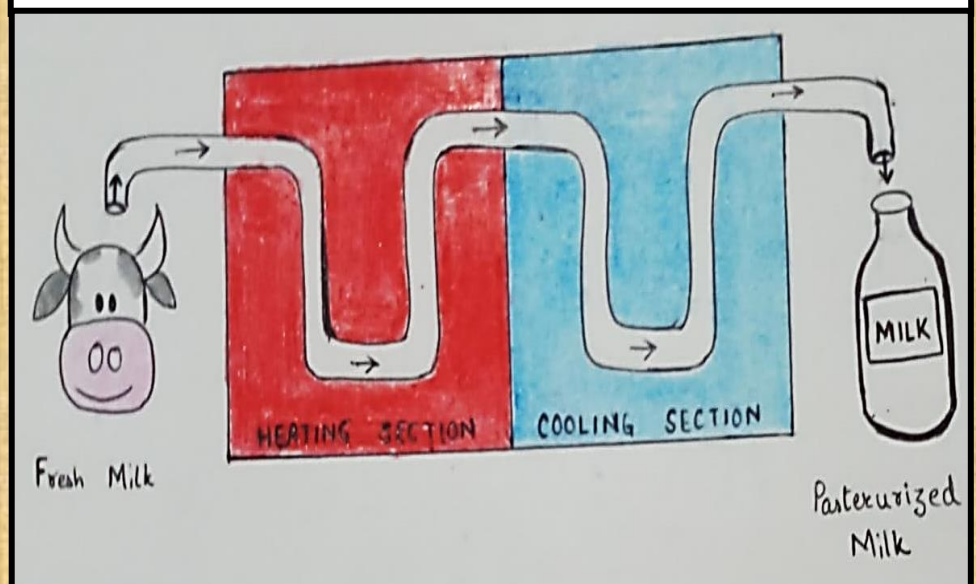
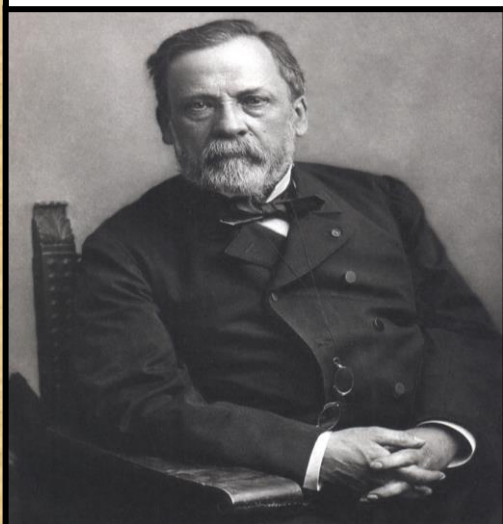
SITA LEARNS ABOUT FOOD PRESERVATION





Pasteurization is a process to inactivate microbes in food and extend their shelf life. This method was discovered by Louis Pastuer.

In this process food items are heated to around 70°C for 15 to 30 seconds and then suddenly chilled and stored.

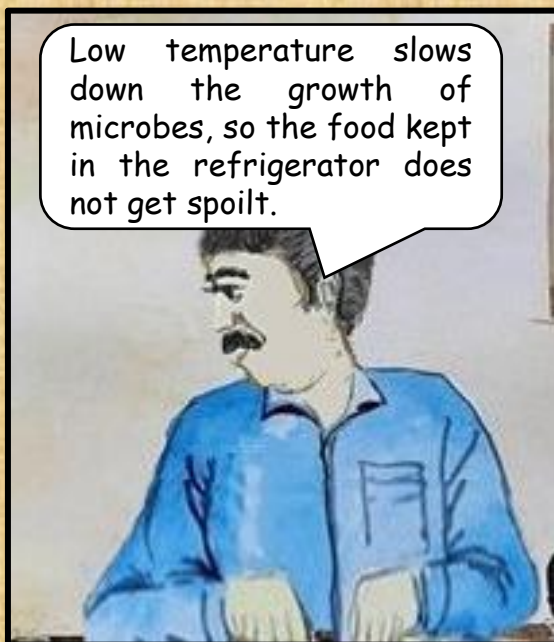




Heat kills microbes, so heating is another method to prevent spoilage of food.



Then, why do we keep food in refrigerator?

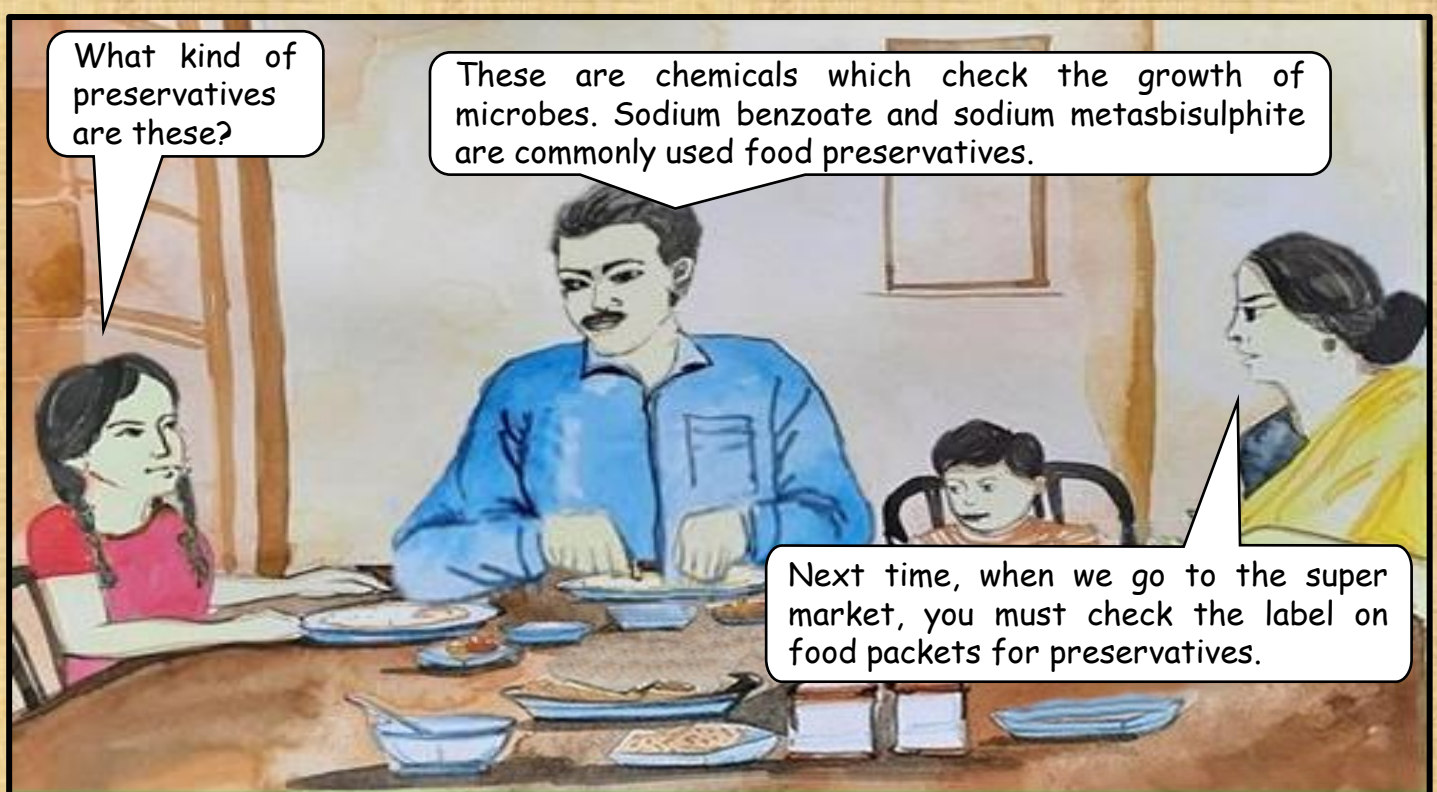


Low temperature slows down the growth of microbes, so the food kept in the refrigerator does not get spoilt.



Please give me some orange juice that Papa got from the supermarket.

I suggest you have some fresh juice because the packed fruit juices and squashes are preserved using chemical preservatives.



What kind of preservatives are these?

These are chemicals which check the growth of microbes. Sodium benzoate and sodium metabisulphite are commonly used food preservatives.

Next time, when we go to the super market, you must check the label on food packets for preservatives.

EPILOGUE



Check your understanding

Answer the following questions

1. Match the food items listed with the correct preservation technique.

a. Milk	i. Drying
b. Fenugreek	ii. Adding Preservatives
c. Orange Juice	iii. Pasteurization
2. Bacteria and fungi cannot live in the environment of oil and vinegar. Give a star if its true or correct it, if false.



-
3. The commonly used preservatives at home are
 - a. Salt
 - b. Sugar
 - c. Oil
 - d. All of these
 4. Jars are kept in sunlight before putting pickles in them. This is done to remove
 - a. Insects
 - b. Moisture
 - c. Air
 - d. Smell
 5. Which of these can last long on the shelf
 - a. Milk
 - b. Tomato
 - c. Banana
 - d. Uncooked rice
 6. How does drying food kill microbes?
 - a. It doesn't
 - b. By using a lot of heat to kill them
 - c. By getting rid of their water source
 - d. By exposing to low temperature to slow down their growth rate
 7. Chemical method of preservation of jams and squashes use preservatives like _
 - a. Salt
 - b. Sugar
 - c. Sodium benzoate
 - d. Oil
 8. Which of these is a good method to store raisins(dried grapes)
 - a. In damp sack
 - b. In a dry container
 - c. In a jar of oil
 - d. In a jar of vinegar

1 a-iii, b-i, c-ii 2. True 3. D 4. B 5. D 6. C 7. c 8. b

GLOSSARY

AIDS	Acquired Immune Deficiency Syndrome
Algae	a group of aquatic, simple non-flowering plants; includes many single celled forms and sea weeds.
Antibiotics	medicines that inhibit the growth of or destroy bacteria.
Antibody	proteins produced by white blood cells to fight infection.
Capsid	the protein coat of virus.
Compost	decayed organic material used as fertilizer for growing plants.
Covid-19	a disease caused by a new strain of coronavirus.
Fogging	a method of killing insects using a fine pesticide spray which is directed by a blower.
Genome	the genetic material of an organism.
HIV	Human Immunodeficiency Virus
Microbes	tiny organisms that cannot be seen by naked eyes; can be seen only with the help of microscope.
Microscope	an instrument used to observe very small objects, invisible to the naked eyes.
Nitrogen fixation	conversion of atmospheric nitrogen to the compounds in the soil.
Pandemic	(of a disease) prevalent over a whole country or world.
Pathogen	disease causing organism.
Pesticide	a substance / chemical used for destroying harmful insects / organisms.
Protozoa	group of single celled microscopic organisms.
Vaccine	a substance that helps to protect against certain diseases. Vaccine contain dead or weakened version of the microbe, which helps the immune system to recognize and destroy the living microbe during a future infection.
Viral load	the quantity of virus in the given volume of fluid: sputum or the blood plasma.

BIBLIOGRAPHY

Following references / websites/ YouTube videos have been referred to during the preparation of this graphic novel.

1. Science Text book for class VIII. NCERT Publication
2. <https://www.the-scientist.com/image-of-the-day/image-of-the-day--67114>
3. https://en.wikipedia.org/wiki/Introduction_to_viruses
4. <https://www.vectorstock.com/royalty-free-vector/vegetarian-food-plate-vector-23122210>
5. <https://www.livescience.com/27458-microbiome-surprising-facts.html>
6. : https://i1.wp.com/www.bioenergyconsult.com/wp-content/uploads/2011/08/How_Compost_Happens.gif?ssl=1
7. <https://steemit.com/agriculture/@oscarcede/compost-an-alternative-in-agriculture>
8. <https://www.slideshare.net/samsmith7568/1-intro-and-history-bio-211vo>
9. <https://jerryjamesstone.com/2016/10/the-science-baking-soda/>
10. <https://www.generalmicroscience.com/microbiology/structure-typical-bacterial-cell/>
11. <https://www.dreamstime.com/illustration/microorganisms.html>
12. <https://digestivecarephysicians.com/2018/06/about-probiotic-supplements/>
13. <https://www.femina.in/wellness/diet/all-you-need-to-know-about-fermented-foods-99336.html>
14. <https://microbiologysociety.org/why-microbiology-matters/what-is-microbiology/bacteria.html>
15. https://en.wikipedia.org/wiki/Root_nodule
16. <https://www.vectorstock.com/royalty-free-vector/hiv-virus-structure-viral-infection-hiv-aids-vector-29518061>
17. <https://collections.nlm.nih.gov/catalog/nlm:nlmuid-101455591-img>
18. <https://www.babydestination.com/missed-vaccination-later-date>
19. <https://www.ivcc.com/world-mosquito-day-2020/>
20. <https://ncert.nic.in/textbook/pdf/eeap108.pdf>
21. https://en.wikipedia.org/wiki/Alexander_Fleming
22. https://en.wikipedia.org/wiki/Edward_Jenner
23. https://en.wikipedia.org/wiki/Louis_Pasteur
24. <https://www.youtube.com/watch?v=D0T65o22Gx8>
25. <https://www.youtube.com/watch?v=jJwGNPRmyTI>
26. <https://www.babydestination.com/missed-vaccination-later-date>
27. <https://www.cdc.gov/hiv/basics/whatishiv.html>
28. <https://www.livescience.com/penicillin-mold-revived-genome.html>
29. <https://images.app.goo.gl/nxRGUY8NBY1eCiHe9>

PRINCIPAL'S DESK

Schooling for millennials must fast-forward its evolution in a world that is changing at an astonishingly rapid pace. Experiential learning, with its proven efficacy, tops the list of preferred pedagogical options for teachers today. The graphic novel is an engaging teaching aid with the potential for a vast outreach and lasting depth of comprehension.



I am proud to present the first graphic novel of Scindia Kanya Vidyalaya, entitled "Sita and Her Secret World of Microorganisms". Weaving this intricate Biology topic into an engaging story for students across classes 8 - 12, has been an exciting exploration of the experiential methodology for us.

This book is a result of the domain expertise of the Science faculty, story telling talent of the English faculty, the technical applications of our IT faculty and above all, the artistic acumen of the Visual Arts faculty of Scindia Kanya Vidyalaya.

I would like to thank our inspirational lode stars: Mrs Anita Karwal, Secretary School Education, Mr Manoj Ahuja, Chairman, CBSE and Mr Sandeep Sethi, Director Education, MSMS Trust, Jaipur, for guiding our first foray into the construction of this teaching aid.

We hope our young readers will enjoy this graphic novel as much as we enjoyed creating it. May it lead them to deep reflection and further explorations.

Mrs. Nishi Misra
Principal
Scindia Kanya Vidyalaya
Gwalior



Scindia Kanya Vidyalaya
Affiliated to C.B.S.E.

Sita & her Secret World of Microbes

Sita is introduced to the secret world of microbes during her experiences as a child. She learns about the novel corona virus and defense mechanism of the human body from a friendly doctor, during her visit to the hospital. Her biology teacher explains about useful and harmful microbes. Curd formation, bread baking, nitrogen fixation, compost formation, etc. are some processes where microbes play beneficial role. Harmful microbes cause many diseases like typhoid, cholera, tuberculosis, etc. Sita learns about the transmission of diseases by mosquitoes from some incidents in her neighborhood. She discovers about antibacterial drugs, antibiotics and their judicious use while discussing a newspaper article with her father. A discussion at the breakfast table introduces her to various methods of food preservation. During this learning process, Sita comes across the contributions of three eminent scientists: Edward Jenner, Ronald Ross and Alexander Fleming. Fascinated by their work, she decides to become a microbiologist. Later in life, her research work in the field of microbiology is appreciated and she is honored with a prestigious award.